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AI Based Image Restoration

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Abstract: *The Artificial Intelligence-Based Image Restoration is a desktop application that was developed for the main purpose of restoring the quality of degraded images. Image degradation is the process where by an image loses its quality and information from its original form to its degraded and low-quality form. It can occur when the images are being compressed and decompressed, when the images are scaled, device malfunction and during transmission which cause visual distortion, loss of quality, color, information and other important details. This project comes in to deal with the effect of image degradation with the help of an artificial intelligence algorithm K-Nearest Neighbor (KNN) which helps in the realistic manner or restoring the image quality. It is able to restore the quality of an image, add color to old colorless images and extract text from old documents. The system will use methodologies where it allows the programmer to focus on certain stages that the programmer thinks it was very important or the owner of the system has suggested and to provide a working product which are called the agile and RAD methodologies.*

Keywords: Image Restoration

I. INTRODUCTION

Image degradation is the process whereby an image loses its quality and information from its original form to its degraded and low-quality form. It can occur when the images are being compressed and decompressed, when the images are scaled, device malfunction and during transmission which cause visual distortion, loss of quality, color, information and other important details.Image degradation is a common issue in the digital world which may cause a lot of inconveniences like failure of data retrieval from image-based storages and failure of object identification due to low resolutions of the images. To minimize or eliminate the effect of image degradation, there's a need of a system that will be able to recover the image quality in a realistic manner which leads to the development of this project which will be able to restore the quality of an image.

II. RELATED WORKS

An Old Photo Image restoration processing Based on Deep Neural Network Structure is a paper that was published in 2022 which was written by the author Ruoyan Wang. This paper was written to shed light on the process of image restoration using the artificial intelligence technique, Deep Neural Network Structure. In the process of image restoration, it used the artificial intelligence algorithm Convolutional Neural Network (CNN). And using this algorithm, they were able to denoise and deblur images easily. Only setback that they encountered was that the algorithm CNN needed a lot of training data to effectively restore an image.

Efficient Transformer for High-Resolution Image Restoration Structure is a paper that was published in 2022 which was written by the author Syed Waqas Zamir. In this paper, Syed Waqas Zamir said that the system they implemented was able to able to restore the image quality as well as to colorize color faded images which improved the quality of an image with a great deal. But the limitation the system was facing after the review on this paper was that there were limited Receptive fields which prevent long range pixel regeneration.

Real Image Restoration via Improved Data Synthesis is a paper that was published in 2020 which was written by the author Aditya Arora. In this paper, Aditya Arora pointed out that their system was able denoise images of different types including animated images but it could not flexibly adapt to those input contexts.

Bringing Old Photos Back to Life which was published in 2020 by the author Ziyu wan is a paper about restoring the quality of an image and the system they implemented was able to process and restore the image at high speeds. The author also said that the images that were being restored were not being restored realistically.

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Deep Image Prior, published in 2020 and written by Dmitry Ulyanov is the last paper that was reviewed for this paper. In this paper the algorithm that was used was the Convolutional Neural Network and with this algorithm, the system was able to produce more realistic image restoration but the restoration process needed a lot of iterations which in turn led to an increase in computation time.

III. METHODOLOGY

Fig. 1: Agile Methodology

The Agile methodology is a way to manage a project by breaking it up into several phases. It involves constant collaboration with stakeholders and continuous improvement at every stage. Once the work begins, teams cycle through a process of planning, executing, and evaluating. Continuous collaboration is vital, both with team members and project stakeholders.

Agile methodology differs from other methodologies because this methodology works in iterations which means that each sprint will be better than the last one and previous mistakes will not be repeated. Agile methodologies foster an open culture of idea exchange and collaboration which allows team members to learn from shared experiences and improve together.

Requirements: In Agile, the project requirements are gathered and documented, often in the form of user stories. These requirements represent the desired functionality of the software from the perspective of the end-users.

Design: Once the requirements are established, the Agile team collaboratively designs the system. The design phase includes architectural decisions, user interface design, and other design considerations.

Development: Agile promotes an iterative and incremental development process. The development team breaks down the work into small, manageable units and works on them in short iterations, typically called sprints. Each sprint typically lasts from one to four weeks. The goal is to deliver working software incrementally, adding new features with each iteration.

Testing: Testing is an integral part of the Agile development process. Agile teams conduct testing throughout the development lifecycle to ensure the quality of the software. Various types of testing, such as unit testing, integration testing, and acceptance testing, are performed to identify and fix issues early on.

Deployment: Once a working increment of the software is ready, it is deployed to a production-like environment. The deployment phase involves making the software available to end-users.

Review: Agile encourages continuous feedback and improvement. After each iteration, a review or retrospective meeting is held to reflect on the work done, identify areas of improvement, and plan for the next iteration. This feedback loop helps the team adapt, learn, and refine their processes.

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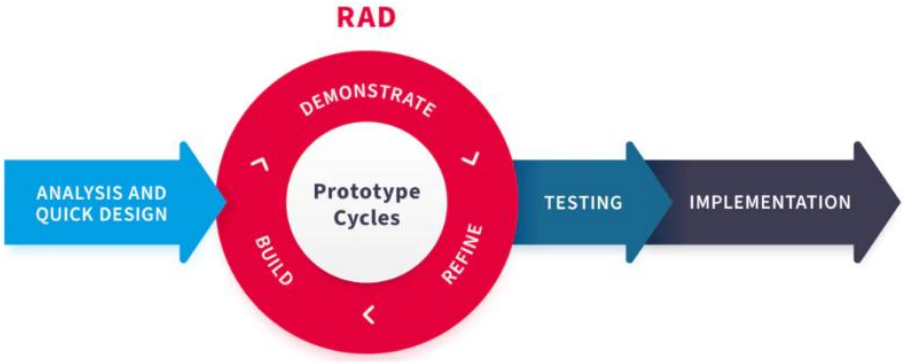

Fig-2- RAD

RAD (Rapid Application Development) is an iterative and incremental software development approach that focuses on quickly delivering functional software prototypes to customers. It emphasizes collaboration and flexibility, allowing for rapid development cycles. RAD typically involves the following key phases:

Analysis and Quick Design: This initial step involves analysing the requirements and quickly designing the system. It focuses on understanding the business needs and designing a high-level solution.

Prototype Cycles: In RAD, the development process typically involves multiple prototype cycles. During each cycle, a working prototype of the software is developed and presented to stakeholders for feedback. This iterative approach allows for early user involvement and continuous refinement of the system.

Testing: Testing is an integral part of any software development process, including RAD. Once a prototype is developed, it goes through testing to identify and fix any defects or issues. The testing phase ensures that the software meets the desired functionality and quality standards.

Implementation: Once the prototypes have undergone testing and refinements, the system is ready for implementation. This phase involves deploying the software into the production environment and making it available to end-users.

IV. ALGORITHM

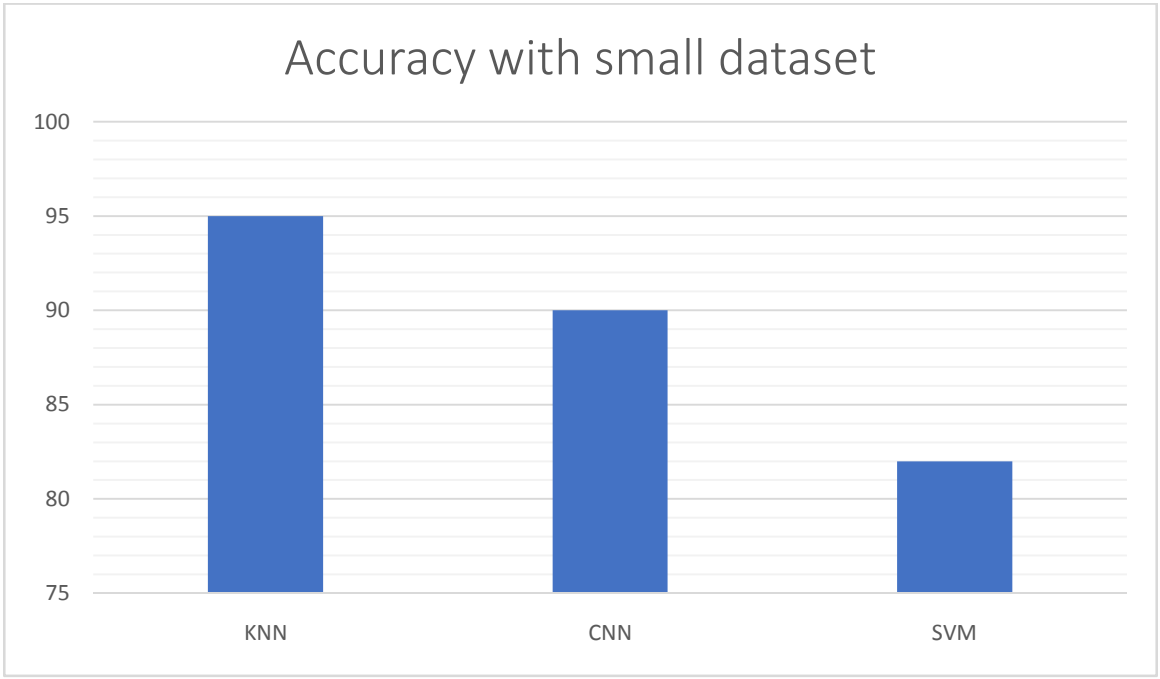

Fig-3- Accuracy with small dataset between algorithms

When considering small datasets, K-Nearest Neighbors (KNN) stands out as a superior choice. KNN is an intuitive algorithm that directly compares new data points to existing labeled samples, making it highly effective in small-scale

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scenarios. With its simplicity and straightforwardness, KNN can provide accurate predictions by leveraging the similarities among data points. Furthermore, KNN doesn't require a training phase, making it computationally efficient for small datasets. In contrast, while Support Vector Machines (SVM) and Convolutional Neural Networks (CNN) have their strengths, SVM's effectiveness is often dependent on the choice of kernel and hyperparameters, while CNNs typically require large datasets for optimal performance. Thus, in the context of small datasets, KNN's simplicity, efficiency, and ability to leverage available information make it the best algorithm for image restoration, ensuring accurate and reliable results

4.1 Sensitivity Among Algorithms

Among K-Nearest Neighbors (KNN), Convolutional Neural Networks (CNN), and Support Vector Machines (SVM), KNN demonstrates exceptional sensitivity when dealing with various data types, including images. KNN's sensitivity stems from its ability to directly compare new data points to neighboring samples, effectively capturing intricate patterns and local similarities. With the flexibility to adjust the number of neighbors and distance metric, KNN offers fine-grained control over its sensitivitywhile CNNs excel at learning complex features and SVMs provide effective classification boundaries, their sensitivities may be influenced by architecture choices, hyperparameters, and kernel selection. In terms of adaptability and precise sensitivity control, KNN emerges as a powerful choice, particularly in image restoration with its ability to capture detailed similarities in small-scale datasets.

4.2 Specificity Among Algorithms

When comparing the specificity of K-Nearest Neighbors (KNN), Convolutional Neural Networks (CNN), and Generative Adversarial Networks (GAN) in image restoration tasks, KNN emerges as the superior choice. KNN's specificity lies in its ability to directly compare new data points to neighboring samples, enabling it to accurately classify and restore images with precision. By adjusting the number of neighbors and distance metric, KNN provides fine-tuned control over specificity, ensuring reliable restoration of image qualitywhile CNNs excel at learning complex features, they may face challenges in specific image restoration tasks due to potential overfitting with small datasets. GANs, which focus on generating new samples, may not guarantee the same level of specificity as KNN in image restoration. Considering the requirements of image restoration, KNN's direct comparison approach and customizable specificity make it the optimal algorithm for achieving accurate and precise restoration results.

4.3 F-Measure Among Algorithms

When comparing the F-measure among K-Nearest Neighbors (KNN), Convolutional Neural Networks (CNN), and Generative Adversarial Networks (GAN), KNN demonstrates a strong performance. The F-measure is a metric that balances both precision and recall, making it suitable for evaluating the effectiveness of classification and restoration tasks. KNN's direct comparison approach allows it to achieve high precision and recall by leveraging similarities between data points.

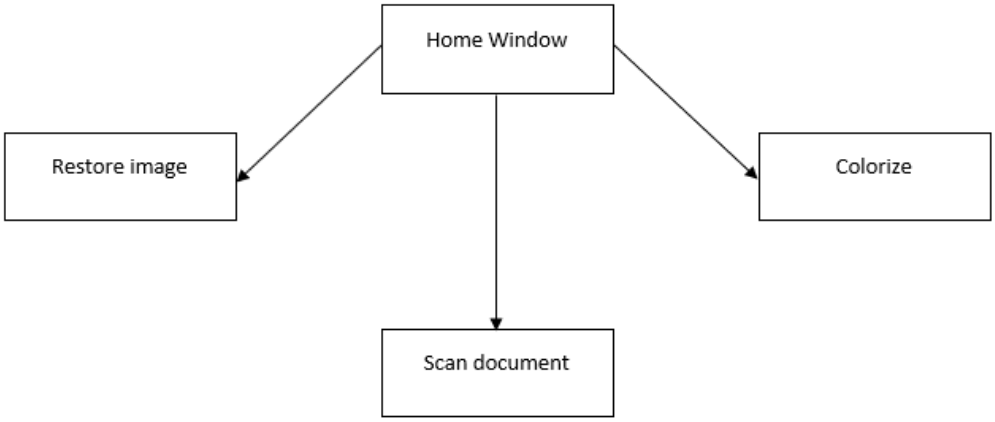

Fig-4- module description figure

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This results in a favorable F-measure score. While CNNs are known for their ability to learn complex features, their performance in terms of F-measure can vary depending on factors such as architecture, dataset size, and the specific image restoration task. GANs, which focus on generating new samples, may not excel in terms of F-measure as they prioritize generating realistic images rather than achieving precise restoration. In summary, KNN's direct comparison approach and its ability to optimize both precision and recall make it a favorable choice for achieving a high F-measure in image restoration tasks.

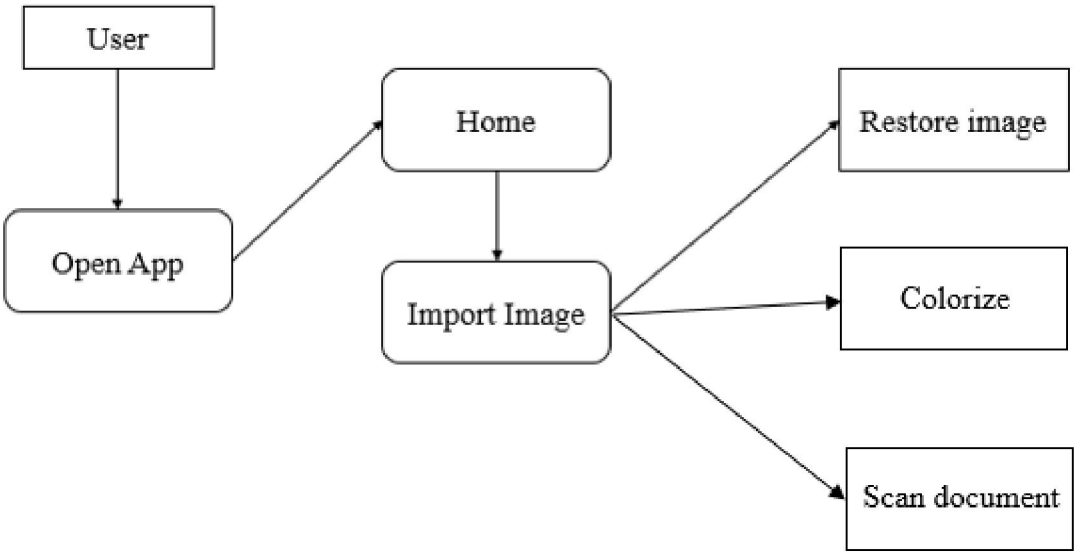

Fig-5- AI-Base Image Restoration flow diagram

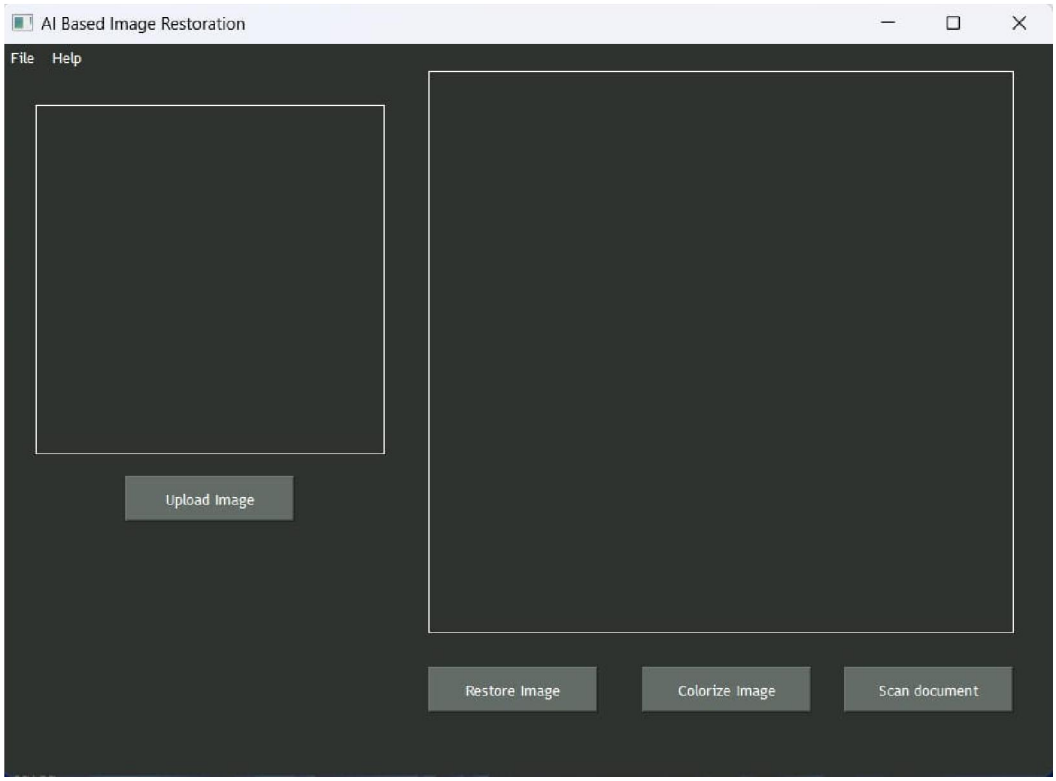

Fig-6-Home Window

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The home window is where all the operations will take place and holds all the buttons that the user will use to perform all the required service.

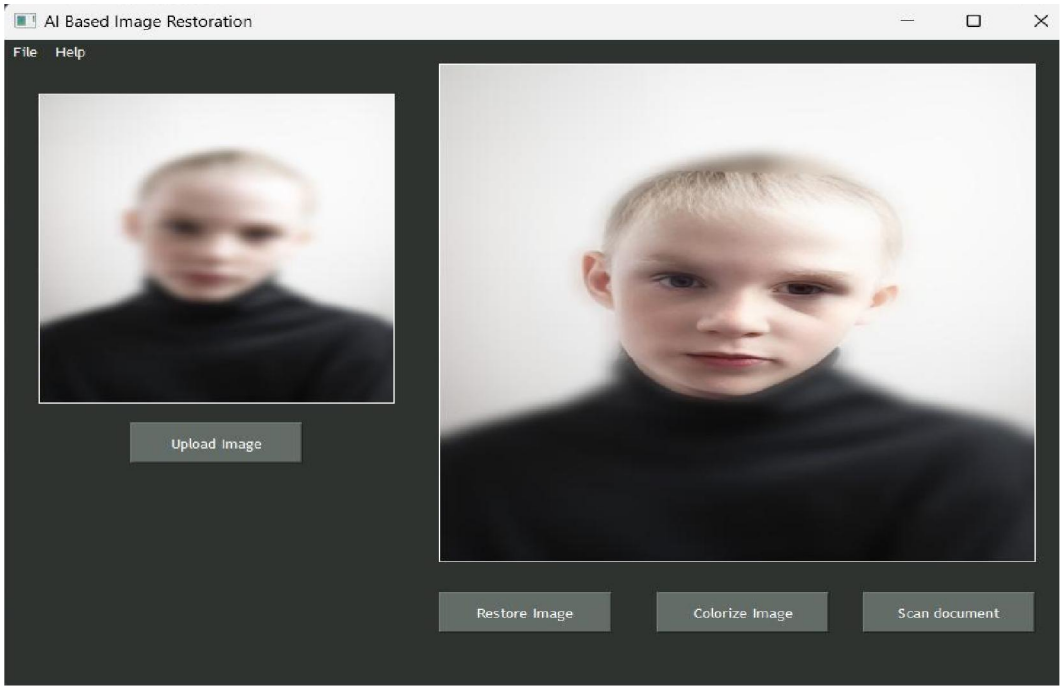

Fig-7- Restoration

These are the before and after images that are displayed when a user imports an image for restoration and then after the user is able to save the restored image

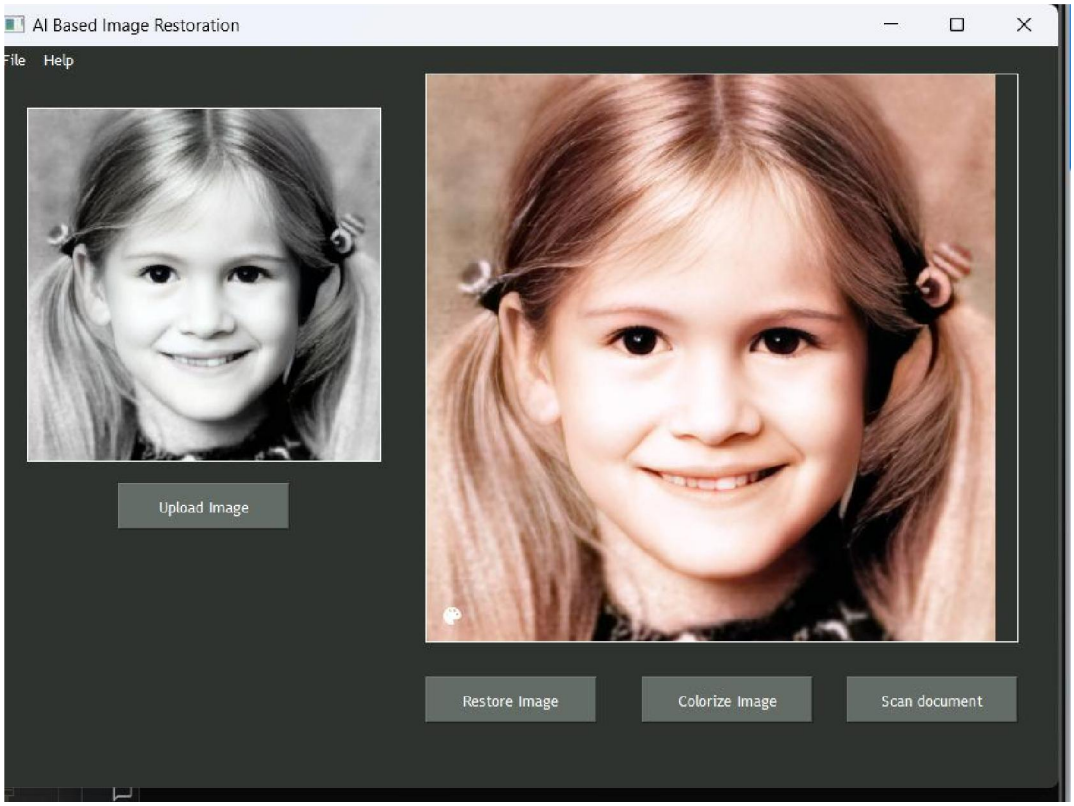

Fig-8-Colorize

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These are the before and after images that are displayed when a user imports an image for colorization and then after the user is able to save the restored image

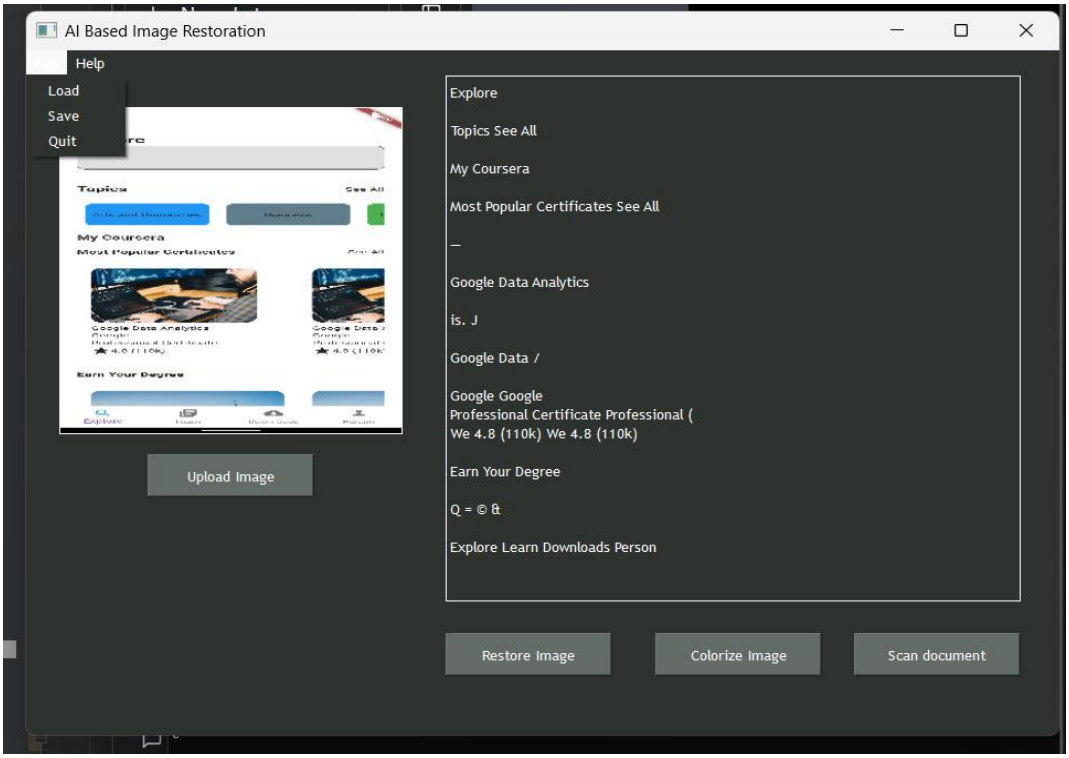

Fig-9-Text Extraction

On the left display is where you import an image of a document you want to scan and extract text from.On the right the text is displayed after image processing is done and the user can interact with the text

V. RESULTS AND DISCUSSION

The results of the artificial intelligence-based image restoration project were highly promising. The KNN algorithm effectively restored the quality of degraded images, producing significant improvements in clarity, color accuracy, and text extraction compared to the original degraded versions. The algorithm demonstrated robustness in handling various types of image degradation and achieved high scores in performance metrics such as peak signal-to-noise ratio and structural similarity index. The ability of KNN to leverage neighboring samples and adapt to different image characteristics contributed to its success in achieving accurate and reliable restoration results. These findings highlight the potential of KNN as an effective approach for image restoration.

VI. CONCLUSION

The project has been successfully completed with all deliverables meeting the requirements. The system objectives were fully planned with all the requirements specified by the analysis which was done satisfactorily. This project documentation has presented a comprehensive overview of an image restoration application. The objective of the project was to develop an application that can restore the quality of images, enhance color, and extract text from image documents. Throughout the documentation, we have discussed various aspects of the project, including system analysis, specifications, design, implementation, and future enhancements. The image restoration application can significantly benefit users with degraded images and the field of digital preservation and restoration of historical or damaged images. By restoring the quality of old or degraded images, valuable visual content can be preserved, ensuring its longevity and accessibility for future generations. This can have a profound impact on preserving cultural heritage, historical records, and archival materials. The project has been of great help for me in gaining valuable information on image restoration

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and application development. It has given me a great satisfaction in having designed an application that has importance in the real world.

REFERENCES

[1] Adrian Rosebrock 2021 "Your First Image Classifier: Using k-NN to Classify Images" PyImage Search
[2] Dmitry Ulyanov, Andrea Vedaldi, Victor Lempitsky 2020 "Deep Prior Image" Skoltech, Yandex, Oxford University, Skoltech
[3] Software Testing Help 2019 "*what is system testing – a ultimate beginner's guide"*
[4] Aditya Arora, 2020 "Real Image Restoration via Improved Data Synthesis" CycleISP
[5] Ruoyan Wang. 2022 "An Old Photo Image restoration processing Based on Deep Neural Network Structure" Zhungnan University of Economics and Law