Optical Character Recognition with Geometric Attacks

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Abstract : Optical character recognition or optical character reader (OCR) is the electronic or mechanical conversion of images of typed, handwritten or printed text into machine-encoded text, whether from a scanned document, a photo of a document, a scene-photo (for example the text on signs and billboards in a landscape photo) or from subtitle text superimposed on an image (for example: from a television broadcast). Widely used as a form of data entry from printed paper data records – whether passport documents, invoices, bank statements, computerized receipts, business cards, mail, printouts of static-data, or any suitable documentation – it is a common method of digitizing printed texts so that they can be electronically edited, searched, stored more compactly, displayed on-line, and used in machine processes such as cognitive computing, machine translation, (extracted) text-to-speech, key data and text mining. OCR is a field of research in pattern recognition, artificial intelligence and computer vision. In this paper, the efficiency of OCR is tested with different kinds of attacks.

Index Terms **- OCR, Attacks, blur, noise, artificial intelligence.**

I. INTRODUCTION

OCR (optical character recognition) is the use of technology to distinguish printed or handwritten text characters inside digital images of physical documents, such as a scanned paper document. The basic process of OCR involves examining the text of a document and translating the characters into code that can be used for data processing. OCR is sometimes also referred to as text recognition.

OCR systems are made up of a combination of hardware and software that is used to convert physical documents into machine-readable text. Hardware, such as an optical scanner or specialized circuit board is used to copy or read text while software typically handles the advanced processing. Software can also take advantage of artificial intelligence (AI) to implement more advanced methods of intelligent character recognition (ICR), like identifying languages or styles of handwriting.

The process of OCR is most commonly used to turn hard copy legal or historic documents into PDFs. Once placed in this soft copy, users can edit, format and search the document as if it was created with a word processor.

OCR can be used for a variety of applications, including:

- Scanning printed documents into versions that can be edited with word processors, like Microsoft Word or Google Docs.
- Indexing print material for search engines.
- Automating data entry, extraction and processing.
- Deciphering documents into text that can be read aloud to visually-impaired or blind users.
- Archiving historic information, such as newspapers, magazines or phonebooks, into searchable formats.
- Electronically depositing checks without the need for a bank teller.
- Placing important, signed legal documents into an electronic database.
- Recognizing text, such as license plates, with a camera or software.
- Sorting letters for mail delivery.
- Translating words within an image into a specified language.

The main advantages of OCR technology are saved time, decreased errors and minimized effort. It also enables actions that are not capable with physical copies such as compressing into ZIP files, highlighting keywords, incorporating into a website and attaching to an email. While taking images of documents enables them to be digitally archived, OCR provides the added functionality of being able to edit and search those documents.

II. REVIEW OF LITERATURE

Majida Ali, Abed Hamid Ali and Abed Alasadi considered a new approach to Simplifying Handwritten Characters Recognition based on simulation of the behaviour of schools of fish and flocks of birds, called the Particle Swarm Optimization Approach (PSOA) [1]. An overview of the proposed approaches to be optimized and tested on a number of handwritten characters in the experiments is presented. The experimental results demonstrate the higher degree of performance of the proposed approaches. It is noted that the PSOA in general generates an optimized comparison between the input samples and database samples which improves the final recognition rate. Experimental results show that the PSOA is convergent and more accurate in solutions that minimize the error recognition rate.

Mohammed Z. Khedher, Gheith A. Abandah, and Ahmed M. Al-Khawaldeh paper describe recognition of characters greatly depends upon the features used. Several features of the handwritten Arabic characters [2]. An off-line recognition system based on the selected features was built. The system was trained and tested with realistic samples of handwritten Arabic characters. Evaluation of the importance and accuracy of the selected features is made. The recognition based on the selected features give average accuracies of 88% and 70% for the numbers and letters, respectively. Further improvements are achieved by using feature weights based on insights gained from the accuracies of individual features.

Ivan Dervisevic deduced that the success of optical character recognition depends on a number of factors, two of which are feature extraction and classification algorithms [3]. The results of the application of a set of classifiers to datasets obtained through various basic feature extraction methods is presented.

Diego J. Romero, Leticia M. Seijas, Ana M. Ruedin presented the recognition of handwritten numerals [4]. A preprocessing method for handwritten numerals recognition, based on a directional two dimensional continuous wavelet transform was proposed. The wavelet chosen is the Mexican hat. It is given a principal orientation by stretching one of its axes, and adding a rotation angle. The resulting transform has 4 parameters: scale, angle (orientation), and position (x,y) in the image. By fixing some of its parameters, wavelet descriptors were obtained that form a feature vector for each digit image. These features were used to recognize the handwritten numerals in the Concordia University data base.

Chirag I Patel, Ripal Patel, Palak Patel proposed recognition of the characters in a given scanned documents and studied the effects of changing the Models of ANN [5]. Today neural networks are mostly used for pattern recognition task. The authors of [5] described the behaviors of different models of neural network used in OCR. The parameters like number of hidden Layer, size of hidden layer and epochs were considered. A multilayer feed forward network with back propagation was utilized. In Preprocessing, some basic algorithms for segmentation of characters, normalizing of characters and de-skewing were applied.

Sushree Sangita Patnaik and Anup Kumar Panda May proposed the implementation of particle swarm optimization (PSO) and bacterial foraging optimization (BFO) algorithms which are intended for optimal harmonic compensation by minimizing the undesirable losses occurring inside the APF itself [6]. The efficiency and effectiveness of the implementation of two approaches are compared for two different conditions of supply. The total harmonic distortion (THD) in the source current which is a measure of APF performance is reduced drastically to nearly 1% by employing BFO. The results demonstrate that BFO outperforms the conventional and PSO-based approaches by ensuring excellent functionality of APF and quick prevail over harmonics in the source current even under unbalanced supply.

Dileep Kumar Patel, Tanmoy Som, Sushil Kumar Yadav Manoj Kumar Singh considered the problem of handwritten character recognition has been tackled with multiresolution technique using Discrete wavelet transform (DWT) and Euclidean distance metric (EDM) [7]. The technique has been tested and found to be more accurate and faster. Characters is classified into 26 pattern classes based on appropriate properties. Features of the handwritten character images are extracted by DWT used with appropriate level of multiresolution tech- nique, and then each pattern class is characterized by a mean vector. Distances from input pattern vector to all the mean vectors are computed by EDM. Minimum distance determines the class membership of input pattern vector. The proposed method provides good recognition accuracy of 90% for handwritten characters even with fewer samples.

Vijay Laxmi Sahu, Babita Kubde explained the classification methods based on learning from examples widely applied to character recognition from the 1990s and have brought forth significant improvements of recognition accuracies [8]. This class of methods includes statistical methods, artificial neural networks, support vector machines, multiple classifier combination, etc. The characteristics of the classification methods that have been successfully applied to character recognition, and show the remaining problems that can be potentially solved by learning methods have been discussed.

Gurpreet Singh Chandan Jyoti Kumar Rajneesh Rani Dr. Renu Dhir presented detailed review in the field of Off-line Handwritten Character Recognition [9]. The recognition of handwriting can, however, still is considered an open research problem due to its substantial variation in appearance. Even though, sufficient studies have performed from history to this era, paper describes the techniques for converting textual content from a paper document into machine readable form. Offline handwritten character recognition is a process where the computer understands automatically the image of handwritten script. This material serves as a guide and update for readers working in the Character Recognition area. Selection of a relevant feature extraction method is probably the single most important factor in achieving high recognition performance with much better accuracy in character recognition systems.

Majida Ali Abed, Hamid Ali Abed Alasadi, considered a new approach to simplifying Handwritten Characters Recognition based on simulation of the behavior of schools of fish and flocks of birds, called the Particle Swarm Optimization Approach (PSOA) [10]. An overview of the proposed approaches to be optimized and tested on a number of handwritten characters in the experiments were presented. The experimental results demonstrate the higher degree of performance of the proposed approaches. It is noted that the PSOA in general generates an optimized comparison between the input samples and database samples which improves the final recognition rate. Experimental results show that the PSOA is convergent and more accurate in solutions that minimize the error recognition rate.

Argha Roy, Diptam Dutta KAustav, Choudhury proposed the adaptation of network weights using Particle Swarm Optimization (PSO) was proposed as a mechanism to improve the performance of Artificial Neural Network (ANN) in classification of IRIS dataset [11]. Classification is a machine learning technique used to predict group membership for data instances. To simplify the problem of classification neural networks are being introduced. This paper focuses on IRIS plant classification using Neural Network. The problem concerns the identification of IRIS plant species on the basis of plant attribute measurements. Classification of IRIS data set would be discovering patterns from examining petal and sepal size of the IRIS plant and how the prediction was made from analyzing the pattern to form the class of IRIS plant. By using this pattern and classification, in future upcoming years the unknown data can be predicted more precisely. Artificial neural networks have been successfully applied to problems in pattern classification, function approximations, optimization, and associative memories. In this work, Multilayer feed- forward networks are trained using back propagation learning algorithm.

Amir Bahador Bayat proposed Automatic recognition of handwritten characters has long been a goal of many research efforts in the pattern recognition field [12]. This paper investigates the design of a high efficient system for recognition of handwritten digits. First it proposes an efficient system that includes two main modules: the feature extraction module and the classifier module. In the feature extract on module, seven sets of discriminative features are extracted and used in the recognition system. In the classifier module, as the first time in this area, the adaptive neuro-fuzzy inference system (ANFIS) is investigated. Experimental results show that the proposed system has good Recognition Accuracy (RA). However, the results show that in ANFIS training, the vector of radius has very important role for its recognition accuracy. At the second fold, it proposes an intelligence system in which a novel optimization module, i.e., improved Bees algorithm (IBA) is proposed for finding the best parameters of the classifier. In test stage, 3-fold cross validation method was applied to the MNIST handwritten numeral database to evaluate the proposed system performances. Simulation results show that the proposed system has high recognition accuracy.

Swagatam Das, Arijit Biswas, Sambarta Dasgupta, and Ajith Abraham proposed Bacterial foraging optimization algorithm (BFOA) has been widely accepted as a global optimization algorithm of current interest for distributed optimization and control [13]. BFOA is inspired by the social foraging behavior of Escherichia coli. It starts with a lucid outline of the classical BFOA. It then analyses the dynamics of the simulated chemo taxis step in BFOA with the help of a simple mathematical model. It presents a new adaptive variant of BFOA, where the chemo tactic step size is adjusted on the run according to the current fitness of a virtual bacterium. And, analysis of the dynamics of reproduction in BFOA is also discussed and also provides an account of most of the significant applications of BFOA until date [14]-[16].

III. Optical Character Recognition

The first step of OCR is using a scanner to process the physical form of a document. Once all pages are copied, OCR software converts the document into a two-color, or black and white, version. The scanned-in image or bitmap is analyzed for light and dark areas, where the dark areas are identified as characters that need to be recognized and light areas are identified as background [17].

The dark areas are then processed further to find alphabetic letters or numeric digits. OCR programs can vary in their techniques, but typically involve targeting one character, word or block of text at a time. Characters are then identified using one of two algorithms:

1. Pattern recognition- OCR programs are fed examples of text in various fonts and formats which are then used to compare, and recognize, characters in the scanned document [18].
2. Feature detection- OCR programs apply rules regarding the features of a specific letter or number to recognize characters in the scanned document. Features could include the number of angled lines, crossed lines or curves in a character for comparison. For example, the capital letter "A" may be stored as two diagonal lines that meet with a horizontal line across the middle [19].

When a character is identified, it is converted into an ASCII code that can be used by computer systems to handle further manipulations. Users should correct basic errors, proofread and make sure complex layouts were handled properly before saving the document for future use [20].

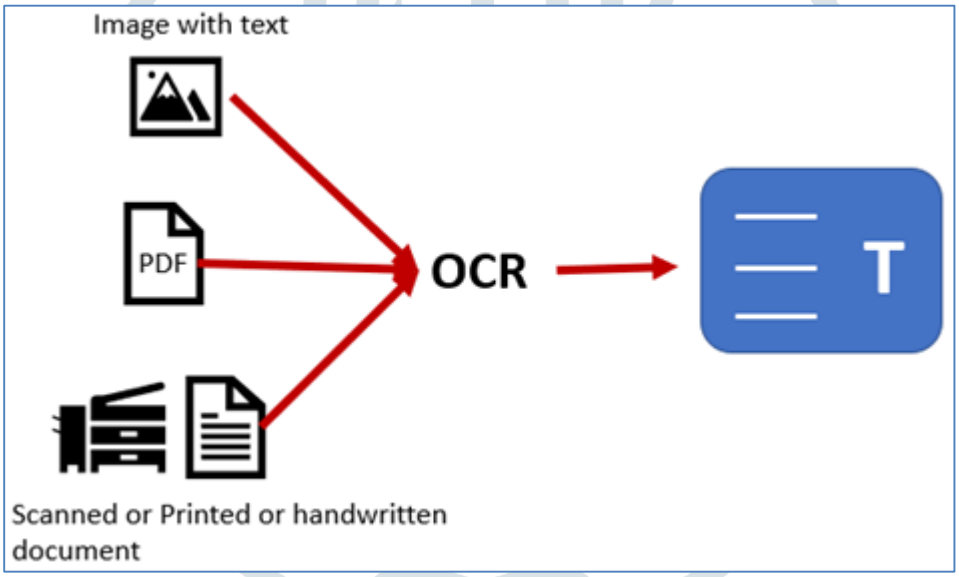

Fig. 1. Process of OCR

How does Optical Character Recognition Work?

Let's have a look at three basic steps of optical character recognition: image pre-processing; character recognition; and the post-processing of the output.

Step 1: Image Pre-Processing in OCR

OCR software often pre-processes images to improve the chances of successful recognition. The aim of image pre-processing is an improvement of the actual image data. In this way, unwanted distortions are suppressed and specific image features are enhanced. These two processes are important for the following steps [21].

Step 2: Character Recognition in OCR

For the actual character recognition, it is important to understand what "feature extraction" is. When the input data is too large to be processed, only a reduced set of features is selected. The features selected are expected to be the important ones while those that are suspected to be redundant are ignored. By using the reduced set of data instead of the initial large one, the performance is increased [22]. For the process of OCR, this is important as the algorithm has to detect specific portions or shapes of a digitized image or video stream.

Step 3: Post-Processing in OCR

Post-processing is another error correction technique that ensures the high accuracy of OCR. The accuracy can be further improved if the output is restricted by a lexicon. That way, the algorithm can fall back to a list of words that are allowed to occur in the scanned document for example [23].

OCR is not only used to identify proper words but can also read numbers and codes. This is useful for identifying long strings of numbers and letters, such as serial numbers used in many industries. To better deal with different types of input OCR, some providers started to develop specific OCR systems. These systems are able to deal with the special images, and to improve the recognition accuracy, even more, they combined various optimization techniques. For example, they used business rules, standard

expressions, or rich information contained in the color image. This strategy of merging various optimization techniques is called "application-oriented OCR" or "customized OCR". It is used in applications such as business card OCR, invoice OCR, and ID card OCR.

IV. ATTACKS

The attacks considered are blurring, Gaussian noise, Salt & pepper noise, Compression, Poisson noise and speckle noise. Blurring is an effect by which the sharpness of the image is lost. The blurring may result from improper focusing of camera, camera in motion or object in motion. The main cause of Gaussian noise in digital data including digital images rise during image acquisition time [24].

For instance, sensor noise resulted from poor illumination and high temperature. Gaussian noise is described by Gaussian function, or simply referred to as a Gaussian, is a of the following form:

$$f(x) = a\, e^{-\frac{(x-b)^2}{2c^2}}$$

The constants a, b and c completely describe the Gaussian function. It is first proposed by the mathematician Carl Friedrich Gauss. The next common noise which occurs in images is salt-and-pepper noise. It is also known as fat-tail distributed or impulsive" noise or spike noise. The name is so given because the image affected by the salt-and-pepper noise will have either completely white or completely black dots added to the original image. The quantity by which these dots get added is in the hands of channel through which the image travels. Another noise of importance in digital images is shot noise or Poisson noise. It is a type of electronic noise which is generally modeled using a Poisson process. Shot noise initiate from the discontinuous nature of electric charge. It also occurs in optical devices in the form of photon counting where it is associated with the particle nature of light. Finally, the Speckle is granular noise that integrally presented in active radar, SAR, medical ultrasound and optical coherence tomography images.

IV. RESULTS AND DISCUSSION

In this section, the simulation results of optical character recognition with geometric attacks are presented. In this paper, attacks like blurring, Gaussian, Salt-and-pepper, Poisson and speckle noise attacks are considered. In Fig. 2, the input image along with image with attack in no attack case, of course, both the images are same in this case.

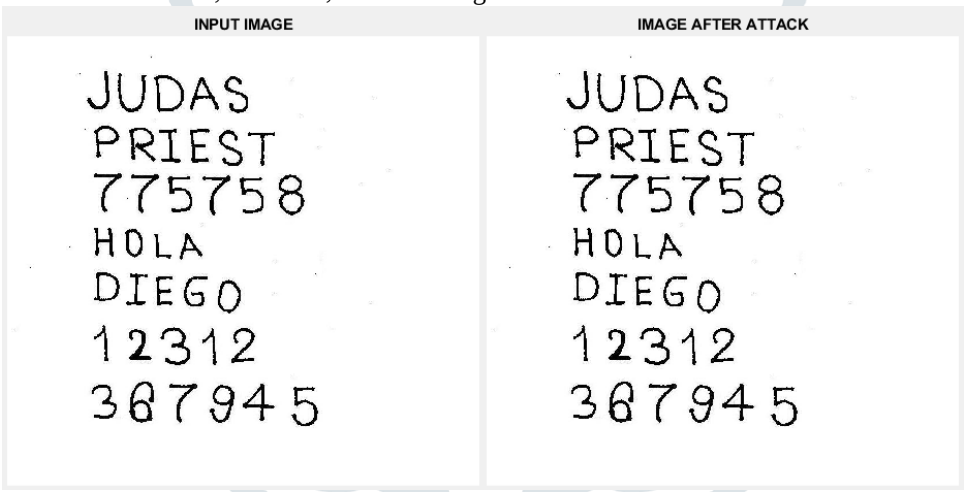

Fig. 2. Input image and image after attack (No attack case)

The following is the output of the OCR for input image (with attack) shown in Fig. 2.

JUDAS
PRIEST
775758
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12312
367945

In Fig. 3, the input image along with image with attack in blurring attack case.

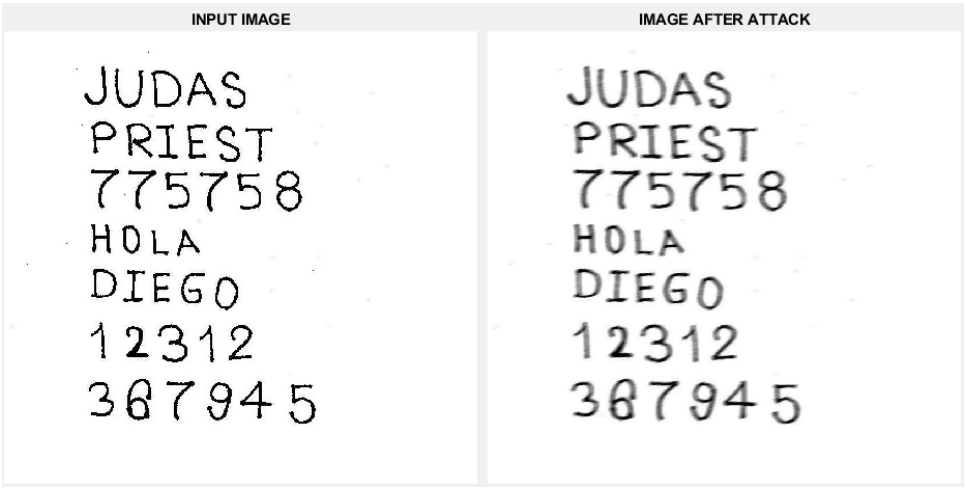

Fig. 3. Input image and image after attack (Blurring attack case)

The following is the output of the OCR for input image (with attack) shown in Fig. 3.
JUDAS
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H0LA
DIECO
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In Fig. 4, the input image along with image with attack in Gaussian attack case.

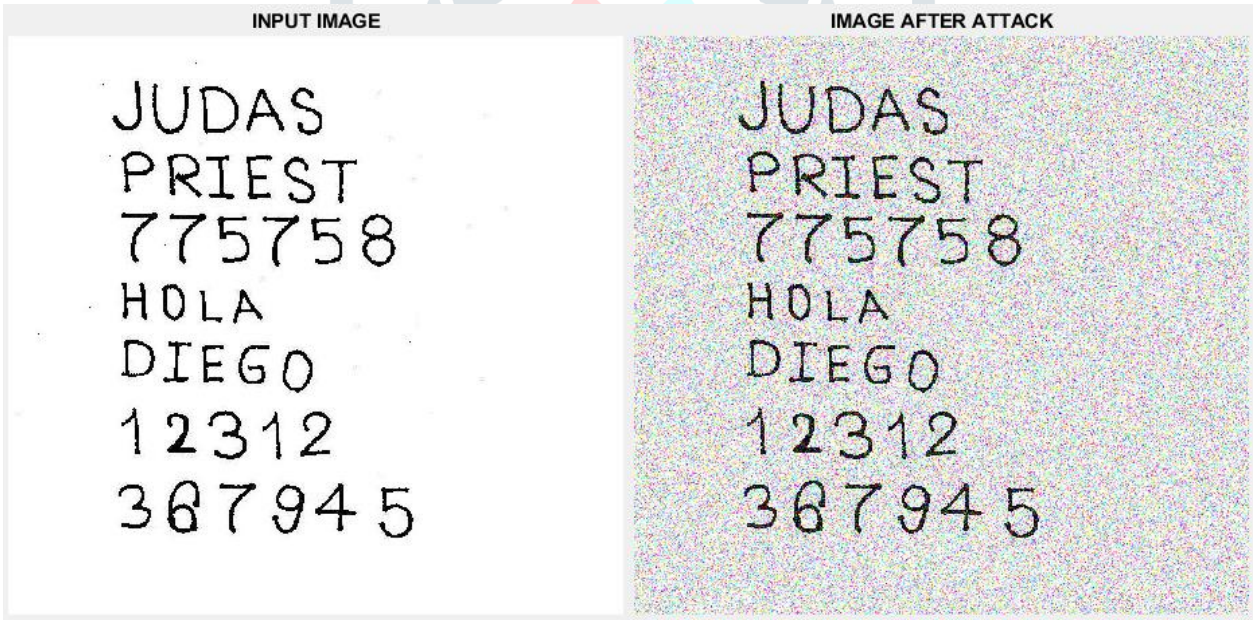

Fig. 4. Input image and image after attack (Gaussian attack case)

The following is the output of the OCR for input image (with attack) shown in Fig. 4.
JUDAS
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HOLA
DIEGO
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In Fig. 5, the input image along with image with attack in Salt-and-pepper noise attack case.

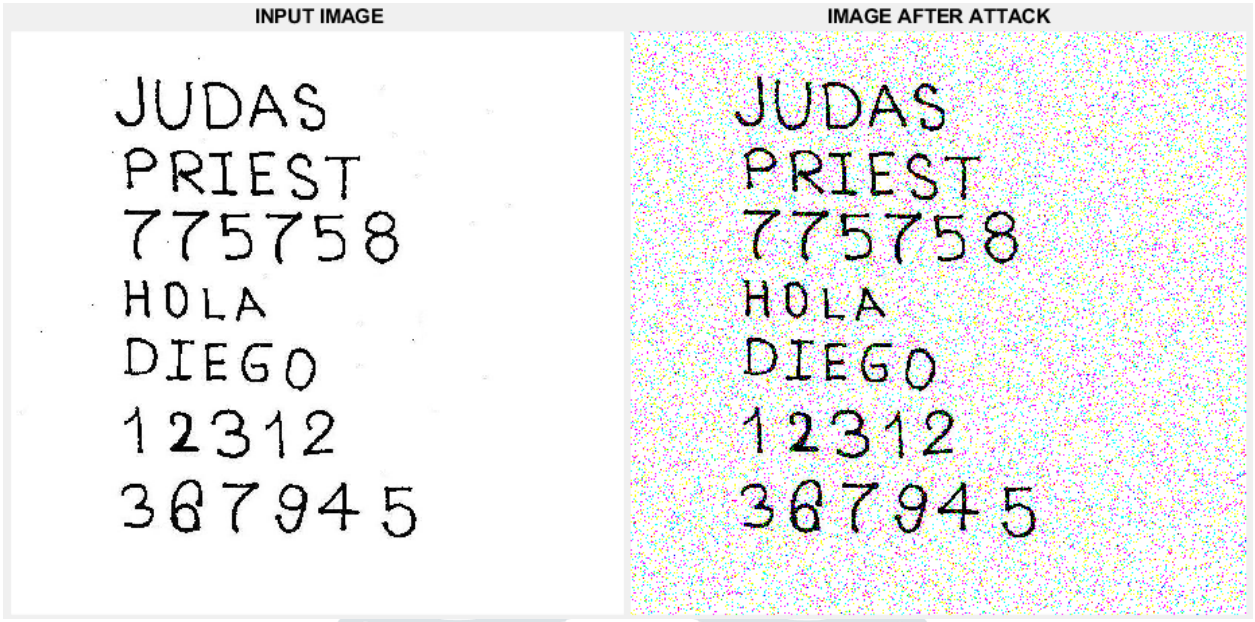

Fig. 5. Input image and image after attack (Salt-and-pepper noise attack case)

The following is the output of the OCR for input image (with attack) shown in Fig. 5.
JUDAS
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DIEGO
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In Fig. 6, the input image along with image with attack in Poisson noise attack case.

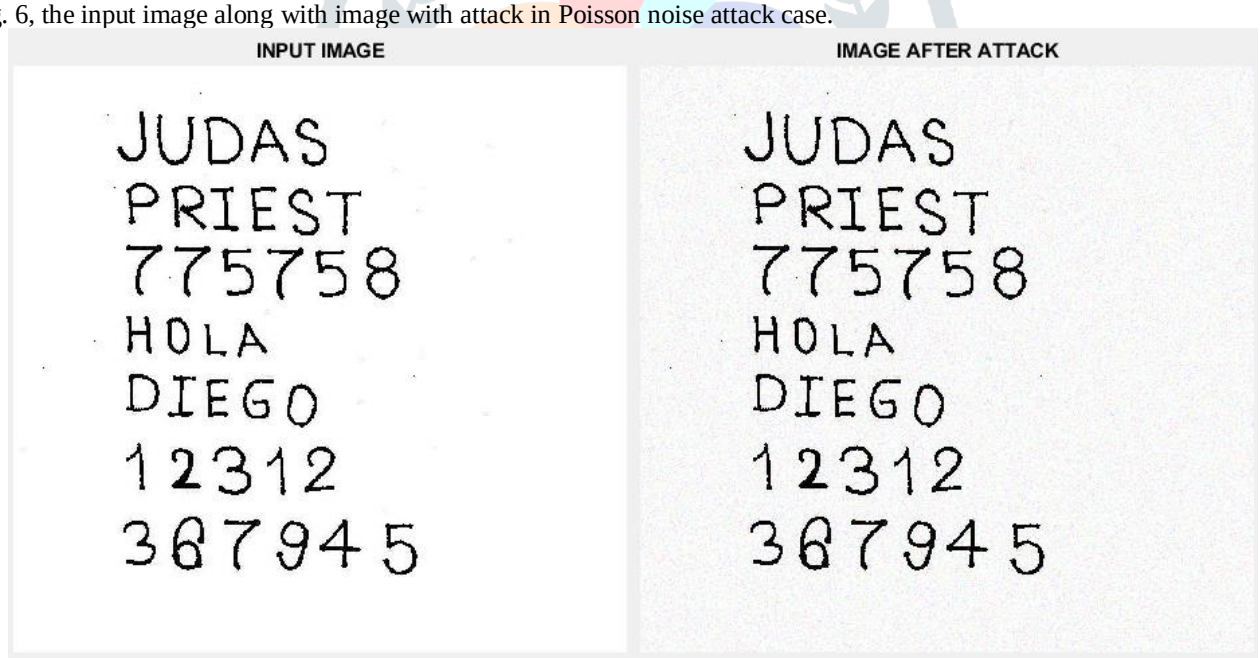

Fig. 6. Input image and image after attack (Poisson noise attack case)

The following is the output of the OCR for input image (with attack) shown in Fig. 6.
JUDAS
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DIEGO
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In Fig. 7, the input image along with image with attack in Speckle noise attack case.

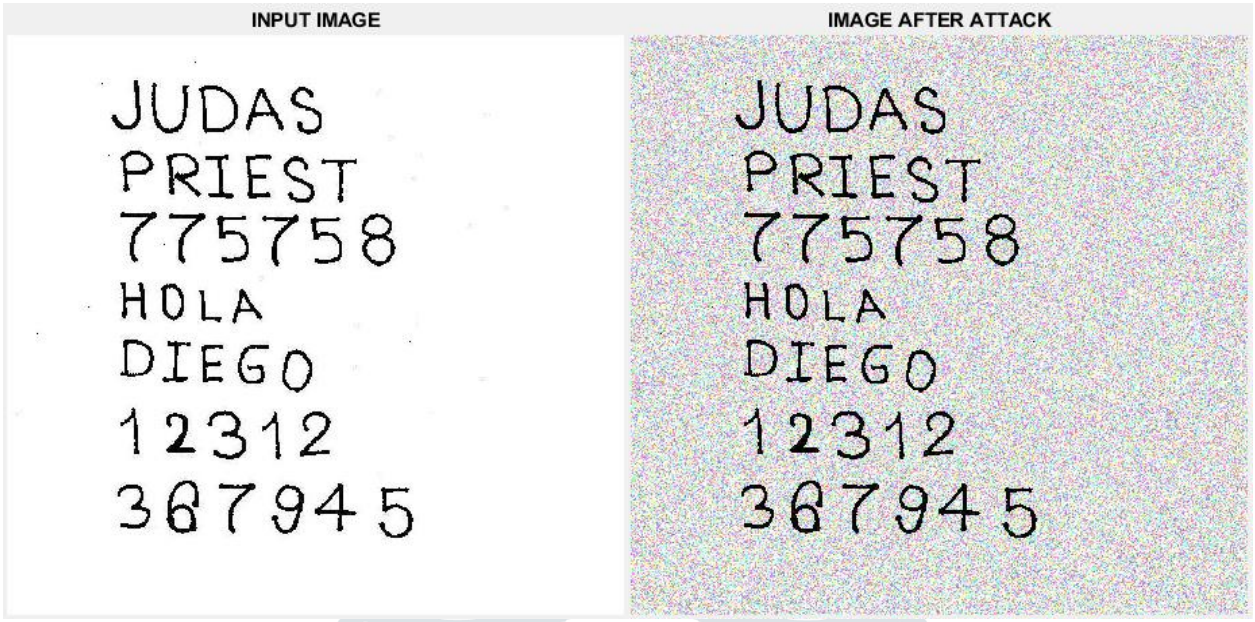

Fig. 7. Input image and image after attack (Speckle noise attack case)

The following is the output of the OCR for input image (with attack) shown in Fig. 7.
JUDAS
PRIEST
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DIEGO
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V. CONCLUSIONS

Optical character recognition aims to convert text present in a scanned document into an editable and portable text fields. The digitalization of older documents require this kind of operation extensively. The conversion of scanned literals require segmentation and pattern matching. The text preserving and preparing a dictionary of all possible literals is needed. If Unicode is supported, OCR can be extended to other languages too. In this paper, the effect of geometric attacks on OCR is considered. Considerable number of attacks are applied on original image and then OCR is performed. Simulation results shown the robustness of OCR.

REFERENCES

[1] Majida Ali, Abed Hamid Ali and Abed Alasadi, "Simplifying Handwritten Characters Recognition Using a Particle Swarm Optimization Approach," European Academic Research, Vol. I, Issue 5, August 2013.

[2] Mohammed Z. Khedher, Gheith A. Abandah, and Ahmed M. Al-Khawaldeh Optimizing Feature Selection for Recognizing Handwritten Arabic Characters Proceedings of World Academy of Science, Engineering and Technology, vol. 4, February 2005.

[3] Ivan Dervisevic Machine Learning Methods for Optical Character Recognition December 18, 2006

[4] Diego J. Romero, Leticia M. Seijas, Ana M. Ruedin, "Directional Continuous Wavelet Transform Applied to Handwritten Numerals Recognition Using Neural Networks," JCS&T Vol. 7, No. 1, April 2007.

[5] Chirag I Patel, Ripal Patel, Palak Patel Handwritten Character Recognition using Neural Network International Journal of Scientific & Engineering Research Volume 2, Issue 5, May-2011

[6] Sushree Sangita Patnaik and Anup Kumar Panda, "Particle Swarm Optimization and Bacterial Foraging Optimization Techniques for Optimal Current Harmonic Mitigation by Employing Active Power Filter", Applied Computational Intelligence and Soft Computing Volume 2012.

[7] Dileep Kumar Patel, Tanmoy Som1, Sushil Kumar Yadav, Manoj Kumar Singh, "Handwritten Character Recognition Using Multiresolution Technique and Euclidean Distance Metric," JSIP 2012, 208-214

[8] Vijay Laxmi Sahu, Babita Kubde, "Offline Handwritten Character Recognition Techniques using Neural Network: A Review," International Journal of Science and Research, India, vol. 2, Issue 1, January 2013

[9] Gurpreet Singh Chandan Jyoti Kumar Rajneesh Rani Dr. Renu Dhir, "Feature Extraction of Gurmukhi Script and Numerals: A Review of Offline Techniques," IJARCSSE, Volume 3, Issue 1, January 2013 pp 257-263

[10] Majida Ali Abed, Hamid Ali Abed Alasadi, "Simplifying Handwritten Characters Recognition Using a Particle Swarm Optimization Approach," European Academic Research, Vol. I, Issue 5, August 2013, pp-532-552.

[11] Argha Roy, Diptam Dutta, Kaustav Choudhury, "Training Artificial Neural Network using Particle Swarm Optimization Algorithm," IJARCSSE, Volume 3, Issue 3, March 2013, pp 43—434.

[12] Amir Bahador Bayat, "Recognition of Handwritten Digits Using Optimized Adaptive Neuro- Fuzzy Inference Systems and Effective Features," Journal of Pattern Recognition and Intelligent Systems, Aug. 2013, Vol. 1

[13] Swagatam Das, Arijit Biswas, Sambarta Dasgupta, and Ajith Abraham, "Bacterial Foraging Optimization Algorithm: Theoretical Foundations, Analysis, and Applications," Hindawi Publishing Corporation Applied Computational Intelligence and Soft Computing Volume 2012, Article ID 897127.

[14] Jaya Krishna Sunkara, M Santhosh, Suresh Babu Cherukuri and L. Gopi Krishna, "Object Tracking Techniques and Performance Measures – A Conceptual Survey", IEEE International Conference on Power, Control, Signals and Instrumentation Engineering (ICPCSI-2017), pp. 333-341, Sep 2017, Chennai.

[15] Jaya Krishna Sunkara, K Subramanyam, V. V. Satyanarayana Tallapragada, V Kiran Kumar, "Image Compression by SPIHT Coding using Traditional Wavelets," Journal of Emerging Technologies and Innovative Research (JETIR), vol. 5, issue 5, pp. 256-267, May 2018.

[16] Jaya Krishna Sunkara, E Sasikala, V. V. Satyanarayana Tallapragada, N Dhanalakshmi, "An Investigation of Image Segmentation Practices," Journal of Emerging Technologies and Innovative Research (JETIR), vol. 5, issue 5, pp. 268-277, May 2018.

[17] Jaya Krishna Sunkara, M Santhosh, C Suneetha, V. V. Satyanarayana Tallapragada, "Vector Quantization – A Comprehensive Study", International Journal of Engineering Science Invention, Volume 7, Issue 5, Ver. II, May 2018, pp. 27-38.

[18] Jaya Krishna Sunkara, Uday Kumar Panta, Nagarjuna Pemmasani, Chandra Sekhar Paricherla, Pramadeesa Pattasani, Venkataiah Pattem, "Region Based Active Contour Model for Intensity Non-uniformity Correction for Image Segmentation", International Journal of Engineering Research and Technology (RIP), Volume 6, Number 1, pp. 61-73, 2013.

[19] Jaya Krishna Sunkara, Sundeep Eswarawaka, Kiranmai Darisi, Santhi Dara, Pushpa Kumar Dasari, Prudhviraj Dara, "Intensity Non-uniformity Correction for Image Segmentation", IOSR Journal of VLSI and Signal Processing, Volume 1, Issue 5, PP 49-57, Jan.-Feb 2013.

[20] Jaya Krishna Sunkara, Purnima Kuruma, Ravi Sankaraiah Y, "Image Compression Using Hand Designed and Lifting Based Wavelet Transforms", International Journal of Electronics Communications and Computer Technology, Vol. 2 (4), 2012.

[21] Jaya Krishna Sunkara, E Navaneethasagari, D Pradeep, E Naga Chaithanya, D Pavani, D V Sai Sudheer, "A New Video Compression Method using DCT/DWT and SPIHT based on Accordion Representation", I.J. Image, Graphics and Signal Processing, pp. 28-34, May 2012.

[22] Jayakrishna Sunkara, L. Ramasubba Reddy, L. Rajyalakshmi, K. Anitha, K. Santhipriya and M. Prathapreddy, "Object Detection with Improved Shape Context Features", CiiT International Journal of Digital Image Processing, Vol. 4, No. 5, March 2012.

[23] Jaya Krishna Sunkara, Kuruma Purnima, Suresh Muchakala, Ravisankariah Y, "Super-Resolution Based Image Reconstruction", International Journal of Computer Science and Technology, Vol. 2, Issue 3, pp. 272-281, September 2011.

[24] Jaya Krishna Sunkara, Kuruma Purnima, E Navaneetha Sagari and L Rama Subbareddy, "A New Accordion Based Video Compression Method", i-manager's Journal on Electronics Engineering, Vol. 1, No. 4, pp. 14-21, June - August 2011.