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An Enhanced Transformation of Computer Handwriting Digital Format using Hybridized Deep Learning Approach

Esau, G.[1], Onuodu, F. E.[2]
[1]*Department of Computer Science, Ignatius Ajuru University of Education, Port Harcourt, Nigeria*
[2]*Department of Computer Science, University of Port Harcourt, Nigeria.*

Abstract: Computer handwriting is the ability of a computer to read and authenticate handwritten characters with a performance that is better than human handwriting. The computer is given a piece of handwriting to produce it into an electronic form. One major recurring problem has been the preserving and transferring of important knowledge due to the traditional method of handwriting. In this work, an enhanced computer handwriting system using Deep Learning Approach was developed. Waterfall process model was used in this approach to facilitate writing process and improve writing styles. The system was implemented with PHP programming Language and MySQL as database. This work could be beneficial to all stakeholders in the educational sector, to the banking industries, to accounting, to auditing sectors, to health sectors, to government parastatals and to agencies including any other organization that deals with computer handwriting for real-time data processing, bill processing, passport verification, signature verification, bank cheques, and post code recognition.
Keywords: Deep Learning, Computer Handwriting.

I. INTRODUCTION

In this era of digitization, electronic devices are truly becoming smarter through the use of simple interface in bridging the gap between humans and computer. These human communication techniques are now a key component in our daily life [1]. Due to curiosity in uncovering and understanding the secret of how humans can recognize handwritten patterns, a lot of efforts are being made to mimic human behavior.

Computer handwriting character recognition is one such area where “Computers” are used to preserve handwritten information so as to retrieve it at a later stage as well as facilitating its mode of communication using deep learning approach. The benefits of using computer in handwriting recognition include easy access, storage capacity, the likelihood of distributing forms and the structures of content search. In spite the huge advancement in technology that facilitates effective writing and higher learning, most people still prefer to take their notes traditionally with pen and paper [2]. However, there are drawbacks to handwriting text. This challenge includes, but is not limited to the difficulties in storing and accessing documents in physical form in an efficient manner, search through documents efficiently and to share them with others.

Computers are able to store large amount of information in a small chip thereby minimizing storage space. Among other benefits of Computer includes quick searching, faster retrieval, easy modification, and deducing new information from existing data. The ability of the computer to interpret an individual handwriting, while still maintaining the uniqueness of such writing, is known as computer handwriting. Although various input devices have been developed to provide facilities for users such as keyboard, mouse, digital pen, stylus, and touch screen.

Therefore, the development of this computer handwriting recognition system will allow users to easily record and bridge the gap between the skilled computer users and those who are not. In the writing process users are allowed to turn their handwriting into a computer font. Bhatia divided computer handwriting into on-line handwriting recognition and offline writing recognition [3]. The ability of the computer to understand scanned writing is called offline handwriting recognition. The approach adopted in this study is centered on using hybridized learning method. The combination of this Learning techniques denotes a machine learning algorithm that is lately applied in solving multitudinous, heterogeneous, and non-realistic datasets which is not limited to image and audio datasets [4].

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II. RELATED WORKS

Kadhm. And Adul Hassan [5] presented a Handwriting Word Recognizer Based on Support Vector Machine (SVM) Classifier. Although their work showed that their polynomial kernel of SVM is convergent and more accurate for recognition when compared with other SVM kernels. But they could not apply this work to text recognition, segmentation method and Neureorks (NNS).

Diaz – Cabrera et al. [6] presented in lexical morphology a model of Western Handwritten Signatures. Although their work convey the knowledge and behaviour in lexical morphology of signatures to human population, suggestion on models and methods of learning such as neuromuscular process of learning and complex cognitive learning. However, they could not measure human behavior.

Chakravarthy [7] presented a Handwritten Text Image Authentication using Back Propagation. Even though their method estimated the boundaries in word probabilities and segmentation via combined segments and distances between connected components. However, their work could not combine various systems to advance overall performance of Password Authentication System (PAS) when using similarity measurement and diverse image features.

Saoji and Dande [8] presented on Digital Pen: How written document convert into Digital form. They introduced how written document is converted into digital form and advantage, disadvantage of Digital Pen. Their work describes how electronic or digital pen work together with ordinary paper to capture pen strokes on a tiny camera. It recorded other capabilities of the system to include recording precise handwriting image and its written form. They also showed how dataset can be uploaded via well-matched mobile phone or a Personal computer (PC). Their work described how digital pen transmits writing into digital media and enumerated the advantages of Digital Pen. Kedar et al. [9] presented the Identification of Personality via Handwriting Analysis. Their work and the methodology used to detect this personality via handwriting analysis and the existing state-of-art associated to it. Although the work implemented various personalities analysis techniques in order to attain the accurate information regarding the peculiarity of each personality but several factors have being found to have affected the correctness of graphology. These factors include ambiguity in handwriting as well as human error, the investigation of their work specifically found prediction to be around 90%. However, individuality classification evaluation of handwriting will bring about an improved and helpful system. Especially, since Artificial neural networks permit a system to be pre-trained and identify characteristics of handwriting and transpose to a conforming personality trait.

Ulusoy [10] presented on The Role of Computers in Writing Process by grouping writing into phases which includes pre-writing, make-up, and rewording and writing. Their work observed that digital Computers can modify the job of writing stress-free and interesting especially to academics and students. The work also ascertained computer as an effective and efficient platform for writing. Writing with the computer offers people more freedom to compose text sequentially, and insert ideas at any given point in the text compared to paper and pen based writing. Abdullah, et al. [11] presented a word sectionalisation using Arabic handwriting. Their work was able to introduce a methodology having an uncomplicated authentication system of Arabic handwritten characters. Their scientific research and technique depended on two end points. Foremost of them is the derivation of characters from pre – processing stage. During this process of pre - processing the word is extracted which is then applied to the process of segmentation so as to obtain the desired characters. Secondly, words having the same letters as those at the database are matched together. This stage basically performs the task of recognizing each character. However, they could not use the algorithm to test more words, and segment width in order to increase the recognition rate.

Aparna and Muthumani [12] presented on a cursive English character via an Optical Character Recognition system. In their work, they were able to examine critically how cursive characters can be scanned and how their pictures can be fed into the computer in order for it to be accepted using a model called Hidden Markov Mode. This in turn carries out a conversion into the same words equivalent to printed characters. In other to totally avoid some rising errors they were able to design an algorithm to handle these challenges. Median filters were used to avoid errors resulting from noise. Their work also showed the use of high-quality samples to reduce the complex nature of recognition process. Isaias et al, [13] presented their conspicuous observations resulting from both the use of Computer and Paper based Resources. They established the interconnection existing in between computer and paper usage. They were able to present complementary roles of these resources along with their competitiveness. But they could not give specific plan of actions where these different tools are compared as to their usefulness not just when it comes to their diverse activities, but also in the various settings where they are employed.

Visessenee et al, [14] presented the techniques used to train data synthesis and the recognition of hand-written documents. They implored a technique called structural crossing over method. In their work they provided a greater variety of patterns. Both vectors and affine transformation were used as a competitive approach. However, their work failed to bring out the use of elastic distortion to the first dataset.

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Somaya et al. [15] presented the role of offline Handwritten using Arabic word-based model. Although, their work endeavored to grouped over one hundred different characters (Arabic text), and there after some changes resulting in the images are removed. But they could not locate the white - black transitions on each image column.

Serrano et al., [16] presented key approaches to be used in character recognition. Although, their work ensured that accuracy was maintained to high level. However, their method was not totally programmed because of it regularly required some level of human intervention in its processes.

Som et al. [17] presented an improved fuzzy system that uses fuzzy function to improve the level of precision of hand-written text. Even though, their work can modify images are from 20 pixels to 10 pixels in each fuzzy class, their system still provides a low accuracy.

Singh et al [18] presented a reduction technique for English Character Recognition. To obtain a high quality reduction rate separation is done row by row. By this reduction method the time for training each system is being converted to a one-layer neural network. Although, in their work characters were divided into scales of 80 pixels each and there after normalization takes place. Typically, this is performed on each input matrices so as to improve the training performance. But the record of their matrices showed a poor result has a low accuracy rate.

III.MATERIALS AND METHODS

A. Analysis of the Existing System

The system analysis is the stage at which the preliminary investigation or feasibility study that must be carried out as fact finding process on the proposed system and in software engineering. Data of the existing handwriting system is collected through several fact-finding techniques such as websites visit and document review. Thus, a study of this existing system shows that there are some level of delay encountered in transmitting hand written documents to others through the use of pen and paper.

Delay in searching or accessing documents manually, the problem of storing and preserving knowledge, and poor appearance of handwritten text among others. The various handwritten recognition techniques, such as Optical Character Recognition (OCR), Artificial Neural Network (ANN), Intelligent Character Recognition (ICR), and Intelligent Word Recognition (IWR). Accuracy rates of all these methods were compared, and the comparative analysis demonstrates that OCR method is the best among them for the recognition of English handwritten characters. Figure 3.1 shows the architecture of the existing system.

B. Disadvantages of the Existing Systems

The existing hand writing method has some problems associated to it, which includes persistent delay in sorting documents; people spend large amount of time searching and locating a particular document. Inefficient storage method; Preservation of document are mostly done manually resulting in the loss of knowledge, especially, in cases of fire outbreak.

Poor appearance of handwritten documents; most hand writing documents can hardly be read because of the poor nature of writing.

The existing system is not fast in processing

It is not complete, i.e. it doesn't have a mathematical interpretation. It is does not have Delete, Undo and Redo futures. The existing system has difficulty in giving space between words.

C. Analysis of the Proposed System

The proposed system is an improved computer hand writing system that will greatly provide a more convenient method of writing with an increased productivity. This system will take handwritten characters as input, process the input, extract the optimal features, train the neural network using both Resilient Back-propagation and Scaled conjugate gradient, to recognize the class of input text, and finally generate the computerized form of input text. Thus, this digitalized technology will aid the management of data storage, information retrieval, data security and easy access to documents. It will enhance real-time data processing, bill processing, passport verification, signature verification, bank cheques, and post code recognition among others. Figure 3.2 shows the block diagram of the training part of the enhanced computer handwriting system and shows the block diagram of the testing part of the enhanced computer handwriting system. The training part of proposed work involves: creation of dataset preprocessing of that dataset, feature extraction from pre-processed dataset, generation of a feature vector and test vector, training of ANN and saving of trained ANN for testing purpose. The testing part involves some extra pre-processing steps such as knowing the number of characters in the input image but it does not include any training of ANN. On the contrary, it uses trained ANN directly after the feature vector generation. The segmentation is an important step of test procedure as it helps figure out number of characters.

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IV. RESULTS AND DISCUSSION

A. Choice and Justification of Programming Language Used

This enhanced transformation of computer handwriting to digital format has been implemented with Hypertext Preprocessor programming language. Hypertext Preprocessor is able to recognize and transform handwritten text and digits. The user of this system draws patterns on the screen, using the natural way of writing. Once the system is trained it takes the unknown pattern as an input and finds out a matching letter to it from the sample patterns taken during the time of training. The actual machine typed letter will then be displayed after exhaustive matching is done by the system. The approach used is a top-down design, concentrating on what first, then and moving to successive levels of details. Figure 4.6 shows the Comparison of HTR Systems with Author(s), Year and Efficiency in the form of Chart.

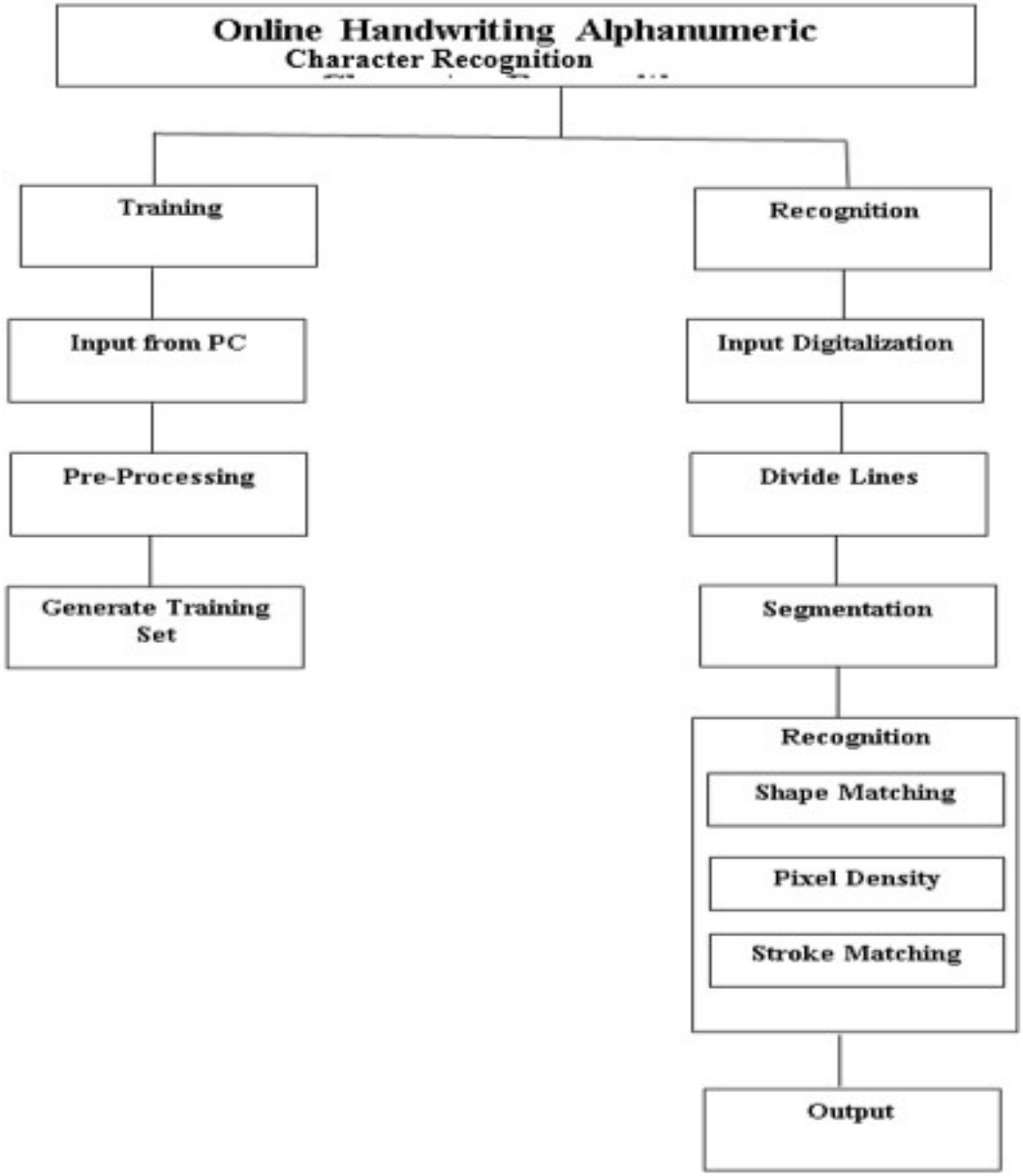

Fig. 3.1 Generic Architecture of the Existing System [19].

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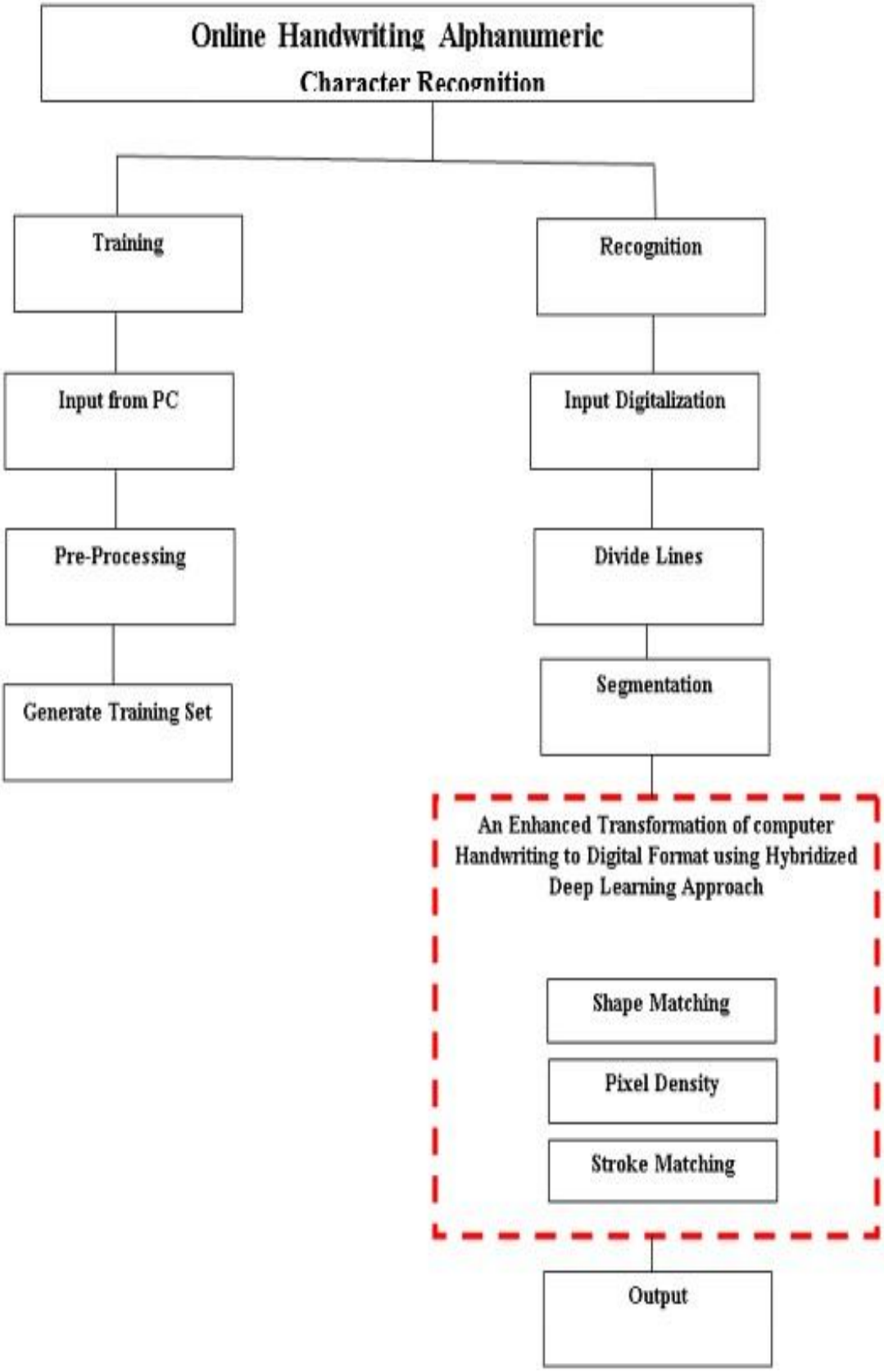

Fig. 3.2 Modified Architecture of Proposed System

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B. Comparative Analysis between Existing Systems and Proposed (Improved) System

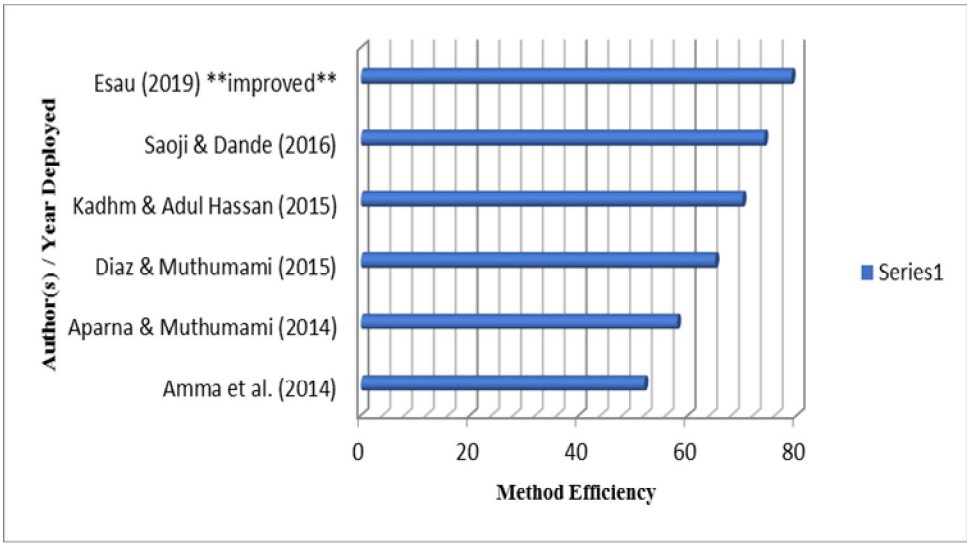

Fig. 4.6 Comparison of HTR Systems with Author(s)//Year and Efficiency in Chart

There are several existing systems being developed in the problem domain or research direction of this study and deployed with different methodologies/integration parameters, hence comparative appraisal was established through participants' observation and content analysis in information technology community and research consortium as shown in table 4.6.

C. Discussion of Results

Figure 4.1 to Figure 4.4 illustrates the welcome screen of the Enhanced Computer Handwriting Interpretation System that is powered by Deep Learning Convolutionary Neural Network (CNN). The welcome screen enables the user to understand the system in order to navigate to the next phase. Another importance of the expected result is that any text appearing in an image can provide useful information for the task of automatic image annotation and other related problems. In order to recognize this text, we first need to detect the real text area inside the image and separate it from the background.

TABLE 4.6 Comparison of HTR Systems with Strengths and Weakness in Tabulation

Author(s)/ Year	Method Used	Strength (s)	Weakness (es)	Efficiency (%)
Amma et al. (2014)	Wearable approach and 3D input	Wireless sensors and accelerometers	Unable to recognize written data	52
Aparna&Muthumami (2014)	Hidden markov mode	Median cursive filter	Limited cursive characters	58
Diaz &Muthumami (2015)	Lexical morphology	Transforming human signature	Lack of behavioral parameters	65
Kadhm & Adul Hassan (2015)	Support vector machine	Polynomial kernel of SVM	Not adaptable to text	70
Saoji & Dande (2016)	Digital Pen	Pen strokes capturing	Image dataset matching	74
Esau and Onuodu (2019)	Hybridized deep learning approach	Text and image data verification /recognition	Not aligned with complex features by KNN/DBN	79

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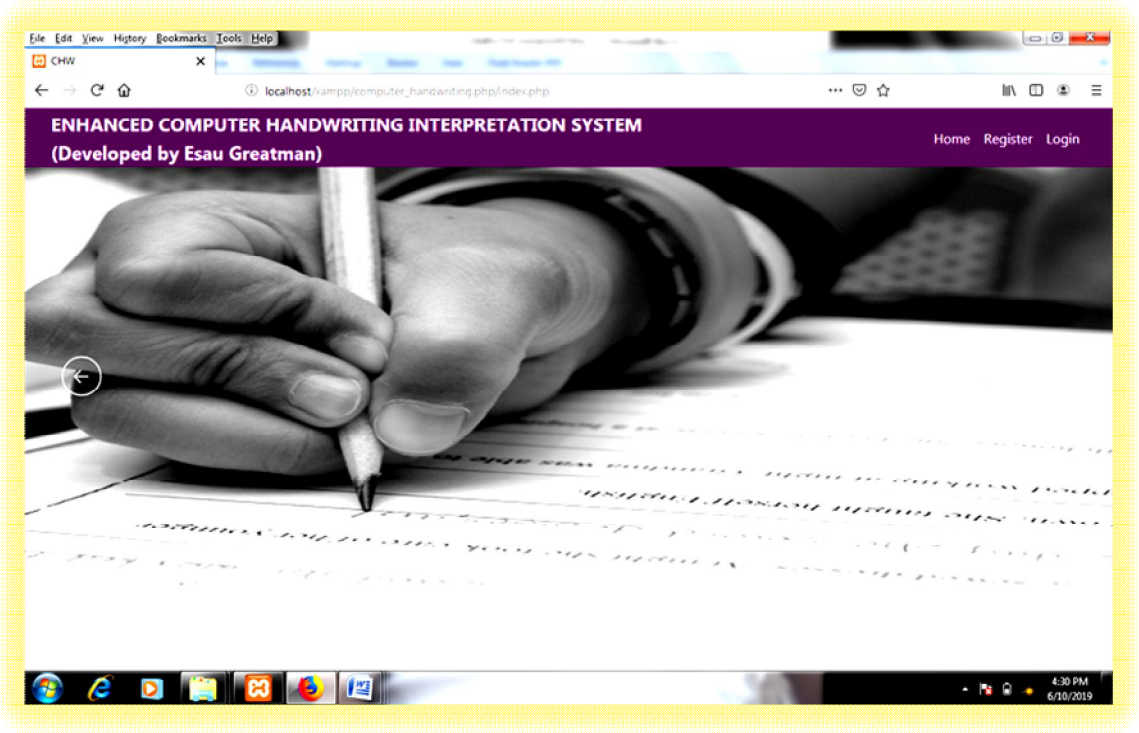

Fig. 4.1 ECHIS: Welcome Page

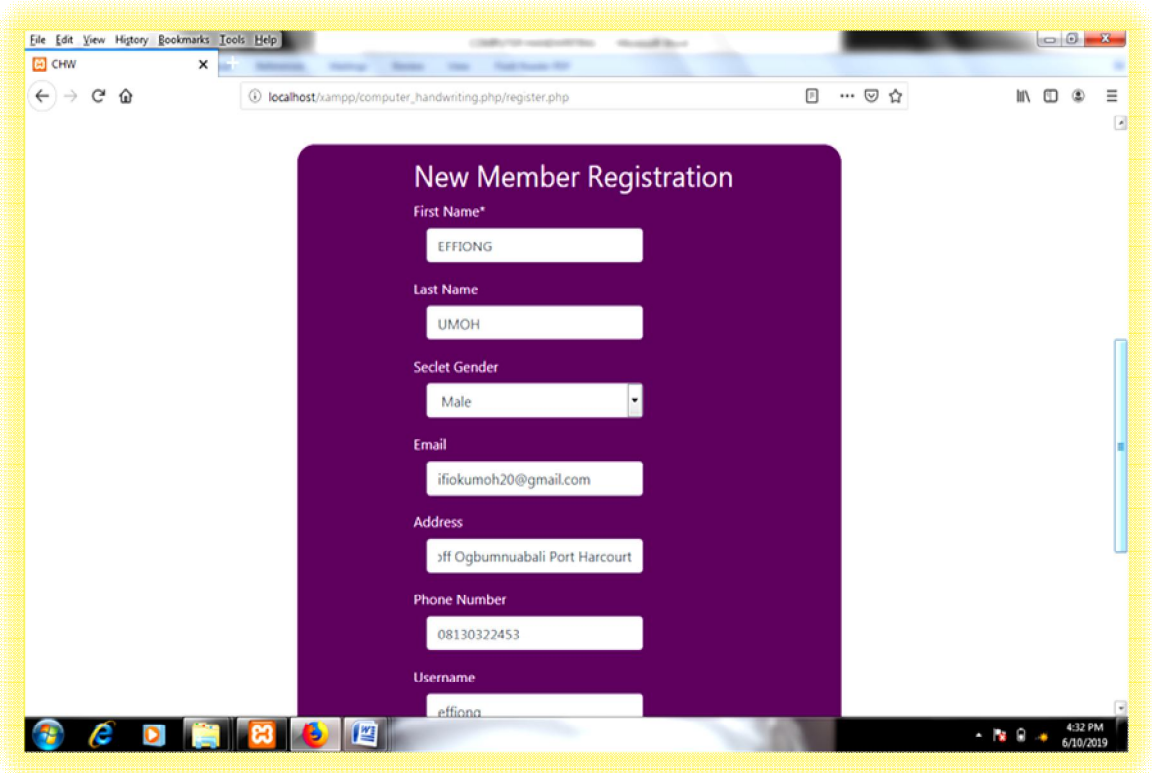

Fig. 4.2 ECHIS: Registration Page

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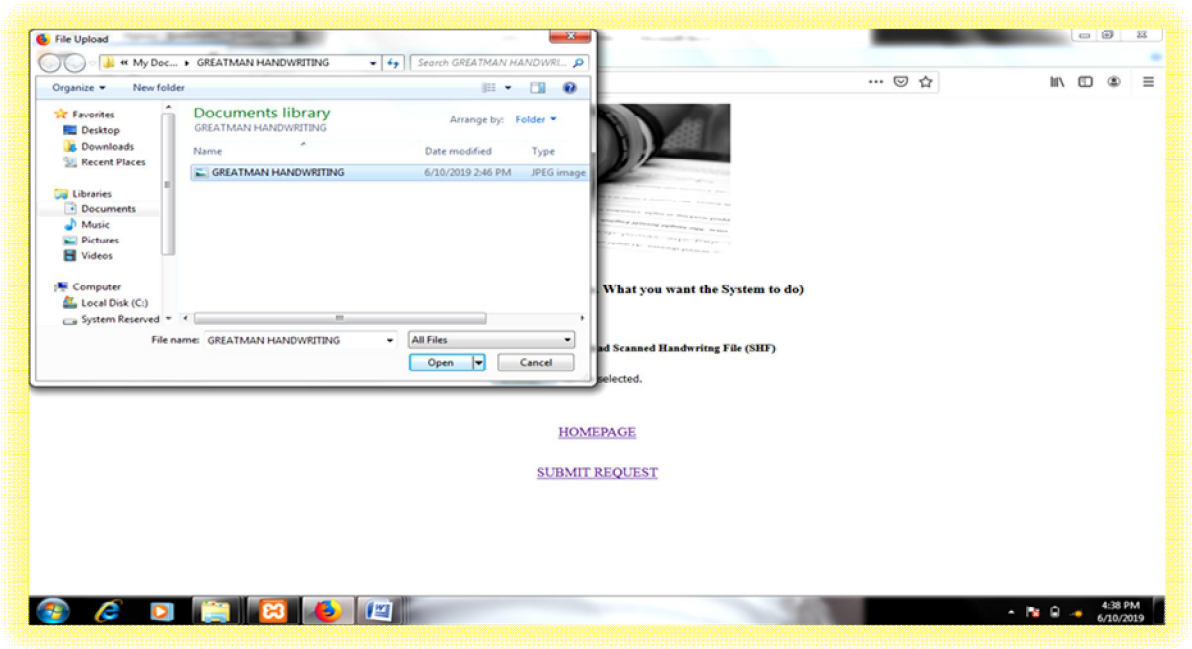

Fig. 4.3 ECHIS: File Upload Page

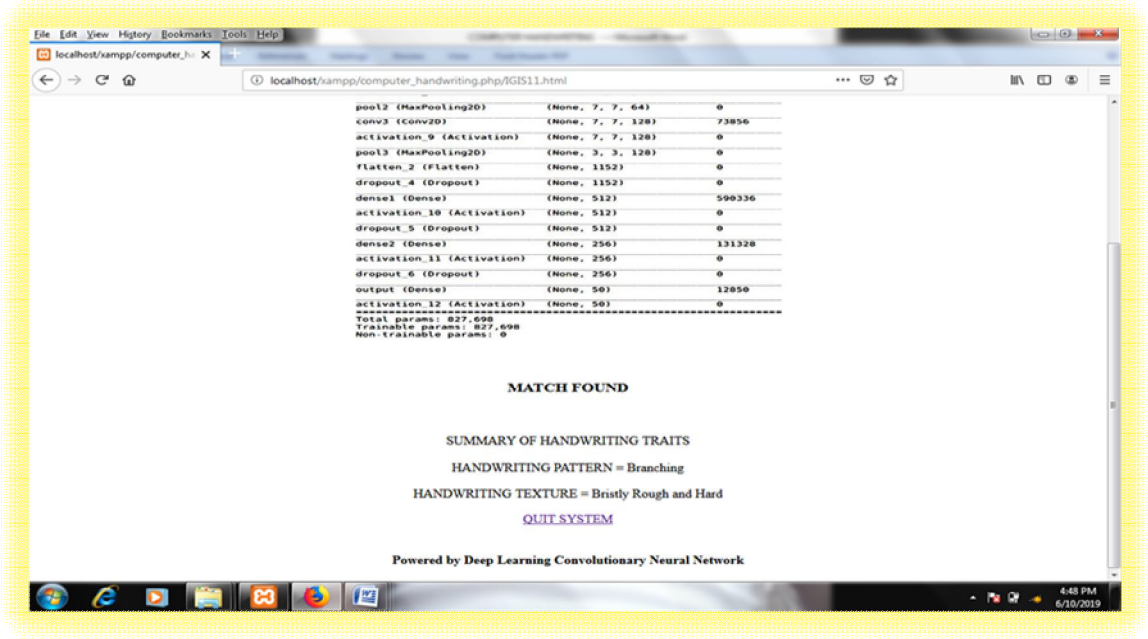

Fig. 4.4 ECHIS: Scanned Result Summary

V. CONCLUSION

The handwriting recognition system will aid people to have an innovative interface for writing. And this will not only be helpful to persons who are inexpert in keyboard operation but also to all who treasure advancement in technology, since this offers platform to enhance communication. The overall, improvement of our recognition engine can be said to address three main error types which includes the removal of unnecessary space errors, certifying the last character of a statement eliminates errors in the system, remembers to concatenate each together. Handwriting has been shown to have some imaginable advantages. Students who take long notes achieve better result than those that use their laptop to type notes. Also many programmers write their pseudo code by hand before typing them to the system.

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VI. RECOMMENDATIONS

In view of the findings of this dissertation work we wish to give these recommendations: The government should give listening ears to researchers and purposively harness the contents of the research for the benefit of all. As part of the initiatives to achieve a higher penetration of current technology, government should make every input mechanism affordable and accessible to all and sundry. People should value others freedom to explore and acquire in all ramifications the sensitivities, self–identity and self-learning habits when terms of their preferred choice of technology. Societies should accept new ideas and products from science and technology, which will in turn continue to influence our lives in all aspect. This work will serve as a contribution to knowledge to improve research work where necessary.

VII. CONTRIBUTION TO KNOWLEDGE

An Enhanced Transformation of Computer Handwriting Digital Format Using Hybridized Deep Learning Approach has been developed. To improve character recognition systems for computer handwriting, transformation process for digital input and verification, especially transaction documents in various organizations can now be segmented. Type matching and digitized nature of real-time data processing makes it controllable to approximate the system response based on inductive learning algorithm for content analysis.

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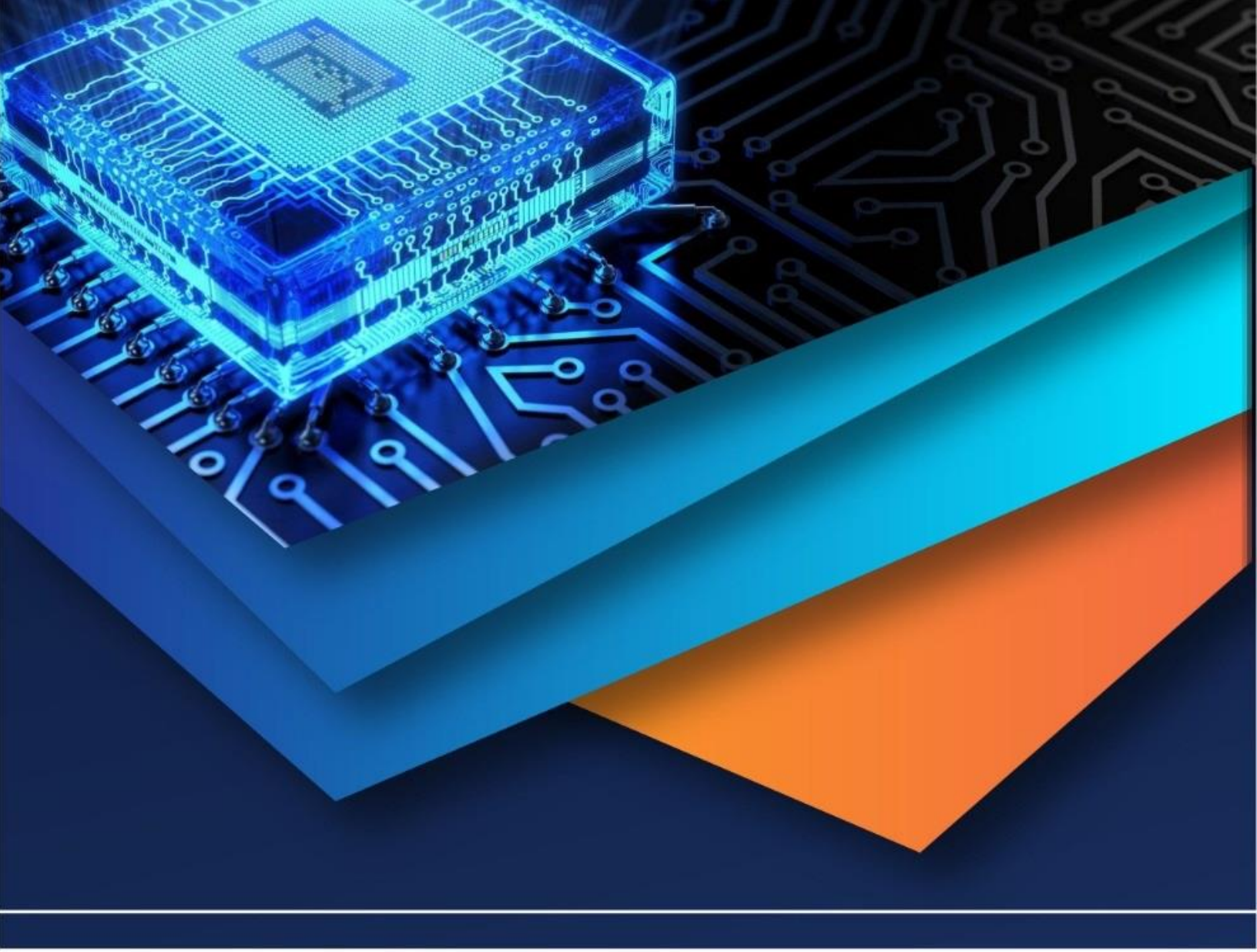

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