Automatic Grading of Figures in Digitalized Answer Scripts

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Abstract— Examinations are used for measuring the knowledge level of students. From previous times itself, examinations are evaluated according to conceptual content present in it. If there is an automated system for evaluating the answers and figures, the evaluation can be done much faster. A new system is introduced for the evaluation of hand drawn images. Handwriting recognition itself is one of the most challenging research areas in field of image processing and pattern recognition. So the purpose of the system is to evaluate the student's hand drawn images and to verify that how much it is correlated with the manual evaluation of images. The texts and shapes that are appearing in the images are extracted using image processing techniques. The grades are calculated by comparing it with the original image. The system aims to make an automated system to evaluate student's hand drawn image which produces the grades and to check whether the system is effective similar to the manual evaluation method.

Key words: Optical Character Recognition (OCR), Handwriting recognition, Digitalized Answer Scripts

I. INTRODUCTION

Examination is the process of evaluating the potential of a student and hence it is necessary to conduct more examinations by an examiner to test the abilities of a student. Examination can be conducted either orally or through written examinations. Oral examination gives quick results to the examiner, while written examination takes much time for evaluation. Consider a University, a number of students join each year for a particular course, conducting oral examination is not feasible for a large group of students. So conducting written examinations is very important. Written Examination takes considerable time for evaluation. It depends on the examination paper evaluator and the persons intended to publish the results. A lot of manual labor is involved in this. A main disadvantage of this type of evaluation apart from time needed is the chance of occurring errors, sometimes more mark will be awarded to the less appropriate one and vice versa. In order to avoid the above problems, computers can be used. A computer does not have senses to recognize or even detect an object or text in an image. A machine like computer should be trained w.r.t an algorithm to do so.

The first approach here is to classify the images drawn by the students and identify some of the common objects and decide whether they belong to any geometric shape or not. The shape of the objects can be represented by some feature space which may be used for recognizing shape of the objects. Detection of regular geometric features [1] like circles, ellipses, rectangles and polygons in digital images is an important exercise in image analysis and computer vision applications such as automatic inspection and assembly. Various methods for regular geometric shape detection have been researched till date. For example:

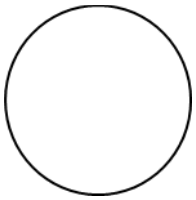

Fig. 1: Shape Example

With human intuition one can easily say that the object in Fig 1 is a circle or a sphere. But what about a computer, how will it recognize this object. It should be provided with an artificial intuition to do so.

The second approach here is document image analysis, comprises of all the algorithms and techniques that are used to convert an image of a document to a computer readable format. Offline handwritten text recognition [2] is a very challenging problem. Apart from the large variation of diff erent handwriting styles, neighboring characters within a word are usually connected, and it is necessary to segment a word into individual characters for accurate character recognition. Many methods achieve text segmentation by evaluating the local stroke geometry and imposing constraints on the size of each resulting character, such as the character width, height and aspect ratio. These constraints are well suited for printed texts, but may or may not hold for handwritten texts.

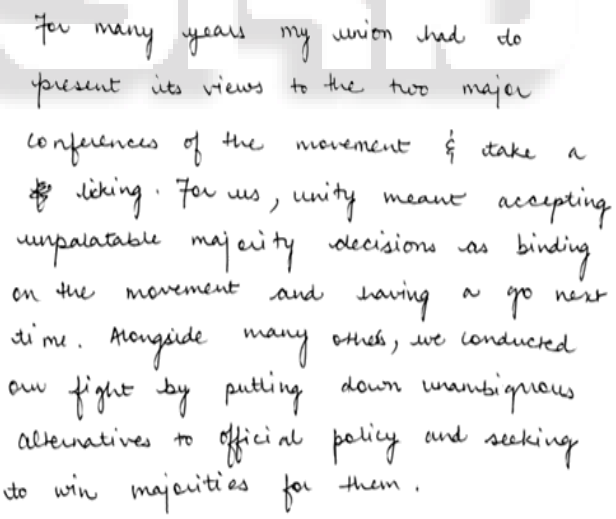

Fig. 2: Handwritten Example

With human intuition one can easily say that the text in Figure 1.1 is a sequence of words. But what about a computer, how will it recognize this text. It should be provided with an artificial intuition to do so.

The image before original processing needs pre-processing. The image taken from a camera or scanner includes noise which introduces certain distortions in the image file which is needed to be eliminated. So it is good to use some filtering techniques like low-pass filtering for Gaussian noise, median filtering for salt-pepper noise, notch filtering for periodic noise etc.

Document Image Analysis [3] pinpoints all the algorithms and processes through which computers can automatically read and represent the information present in an image of a document. A wide range of useful information which has been conventionally stored as documents on paper, is now being converted into digital form. These documents can include machine printed documents such as technical reports, handwritten documents such as personal letters or addresses on postal mails, online handwritten documents such as PDA or hand held devices acquired documents, or video documents such as images from a video containing text and so on. The algorithms and processes developed in document image analysis enable computers to automatically find out the contents present inside the documents.

Document image analysis techniques can be broadly classified into either Optical Character Recognition (OCR) based techniques or Non-OCR based techniques. OCR has various applications in various fields such as banking, health care, digital libraries, digital repositories, legal industry, license plate recognition, handwritten letters recognition etc. Significant research has been done in recent decades, it leads to a high recognition rate, but these recognition rates can drop considerably in presence of image artifacts such as distortion introduced during scanning of the documents.

Typically an OCR system is applied to printed texts or handwritten texts and can significantly reduce the time needed to convert a document to computer readable form, as compared to the time needed for a human to manually enter the same data. Even though much research effort has been put into development of algorithms and methods to automatically convert documents into digital format in recent years, many documents that are easy to read for humans can achieve approximately 92% recognition accuracy. This makes the automatic document conversion process still unreliable to entirely remove humans from the process, thereby increasing the time and cost required in digitization of document images. Most commonly these low accuracy rates is caused by the image degradations that exist in the document images, which are caused at the time of printing, scanning, photocopying etc. of the documents. One solution might be to make the entire systems more robust against these degradations, but sometimes even this might not work. Therefore it is necessary to develop algorithms which will handle these kind of degradations even before the step of OCR is utilized. Moreover, there are various techniques available to detect object of a particular geometric shape from 2D image. But they are not much reliable techniques that identify features of objects of an image and recognize the object having geometric shape like circle, square, rectangle and triangle.

To identify the shape of detected object, generally the technique used region properties. A technique which identify the shape of object using Edge Detection Technique and Region Properties together to get more reliable and accurate result from other methods of object detection.

The need for computer-assisted assessment of learning outcomes is connected to two inter-related factors in today's schooling and education markets. First, teachers need to automate the assessment and evaluation process especially in mass courses. Secondly, a student, may want to assess the degree of his or her own learning process prior to an examination. Evaluation is a broad concept which covers both formal and informal.

II. RELATED WORK

There are various techniques available to detect object of a particular geometric shape from 2D image. But they are not much reliable techniques that identify features of objects of an image and recognize the object having geometric shape like circle, square, rectangle and triangle. To identify the shape of detected object, generally the technique was developed is using region properties. The Basic 2D Object Detection [1] is a technique in which, it will identify the shape of object using Edge Detection Technique and Region Properties together to get more reliable and accurate result from other methods of object detection.

The Basic 2D Object Detection is divided in three phases. First is Edge Detection. In this phase, it detects edges of objects of input image using Edge Detection technique. The Edge Detection technique is detects the edges of the objects. So, we can easily separate the objects of given image. Then the second phase is Image Segmentation, in which each object is separated by labeling each region. And finally the third phase is Shape Recognition that identifies the shape of each object or region of an image and recognizes the object having basic geometric shapes like circle, square, rectangle or triangle. This will be achieved by applying region properties to each detected object or region of an input image.

Image Shape recognition [7] represents a procedure employed to extract information from acquired images. It is very large fields that include human face recognition, handwriting recognition, finger – prints recognition, etc. Shape recognition means a classification and/or a description of the image contain. The classification consist in attribution of an unknown shape from the acquired image to a class from a set of predefined classes; the classifying operation produce an output image which represents a map of the objects of the scene in the image. In the new image, the values of the pixels represent actually the codes associated to corresponding classes. This classification uses mathematic methods of theoretic decisions or statistics, methods that are based on a few elements of the theory of statistic decisions.

When the shape to recognize are very complex or the number of classes is high and cannot be determined (the elements - part of the object can combine in an infinity of ways), then the theoretic-decisional methods cannot be used. This is the case of the scenes, for example in robotics, when the objects arranged one by another must be recognized and extracted one by one from the stack. The complex form is seen as a combination of simpler forms which are recognized one by one and then established the relationships between them, on regard of describing the object. If every of this form is, at its turn, a complex form, than simpler forms, represent it until the simplest forms, called primitives.

The recognize section is represented by processing, the extraction of primitives and the structural – syntactic analysis, including the selection of the primitives and the structural inference. In the syntactic recognition, a form is represented by a set of primitives. The rules followed by the components of the shapes are specified by the grammars of

the forms description language. The structural recognition may use a relational graph or another type of representation to specify the relationships between shapes on regard of describing the object or the shape.

There is no general rule to select the primitives. Usually, the primitives are easily recognized. Many times, a compromised must be made between the complexity of the elementary shape and the complexity of the description grammar. Generally, as the shapes are more complex, the relationships between them are simpler. After the selection of the primitives, the next step is the construction of some grammars capable of generating one or more languages to describe the studied shapes. The selection of one grammar depends of the selected primitives and of the compromise between the descriptive power of the grammar and the efficiency of the syntactic analysis.

The decision of recognition or acceptation of a shape is taken by syntactic analyzer. Usually use one or more grammars for each of the class or shape, the classification meaning the determination of the grammar that accepts a representation of a shape as correct.

Hand-drawn images are used widely as clinical and neuropsychological diagnostic tasks for a variety of conditions including Parkinson's disease, dyspraxia and visuo spatial neglect. Typical task configurations include the copying of simple geometric shapes such as squares, crosses and cubes and the completion of images, for example forming a mirror image of a given shape. Assessing performance on each individual side of the visual field is particularly important for the diagnosis of visuo-spatial neglect a condition which can occur following a stroke whereby subjects fail to respond to stimuli to one side of their visual field. Assessment of test responses relies on the application of a set of marking criteria based on the presence (or absence) of drawing components. Performance assessment has been found to be subjective, with disagreement occurring between trained assessors each applying their own interpretation to marking criteria. As these tests contribute to a patient's diagnosis and recovery monitoring throughout their stay in hospital, accuracy, consistency and repeatability in assessment are of importance. R.M. Guest, et.al, proposed a method [8] to automatically segment a hand-drawn image into horizontal, vertical and diagonal components and reporting their location within the drawing. More importantly, it will be shown that this information can be used algorithmically to establish the presence of constituent shape components and their spatial relationship and hence produce a series of standardized performance scores based on the outcome of the drawing.

The Canny Edge Detector [9] is widely considered as the standard Edge Detection algorithm in Image Processing. In Canny algorithm, the Gaussian function is used to smooth the image prior to edge detection. The filtering or smoothing operation actually services two purposes. The first one is the reduction of the effect of noise prior to the detection of pixel intensity changes. The second purpose is setting the resolution or scale at which intensity changes are to be detected. These factors contribute effectively towards a precise edge detection method, overcoming the problem of detecting false edges resulted from noise sitting on some pixels.

For handwriting text recognition [2] the input to the system is a scanned image containing handwritten text paragraph. The image should be in prescribed format such as jpeg, png etc. It consists of two phases. Preprocessing stage and Character Segmentation and Recognition stage. Preprocessing is the major step in handwriting recognition system. It employs several step, that is, line segmentation, skew correction, baseline correction etc. It takes input as a raw running text image and gives output as segmented words. In the Character Segmentation and Recognition stage, an image of each word received from previous step is decomposed into sub-images of individual characters. Characters can be segmented by two approaches namely Heuristic based segmentation and neural network approach. Handwritten character recognition [10] is a difficult problem due to the great variations of writing styles, different size of the characters. Multiple types of handwriting styles from different persons are considered. An image with higher resolution will certainly take much longer time to compute than a lower resolution image. In the practical image acquisition systems and conditions, shape distortion is common processes because different people's handwriting has different shape of characters.

III. PROPOSED SYSTEM

The method for grading figures consists of the following steps. Initially a figure obtained from the subject is fed to the system. That figure is pre-processed and then the preprocessed images are used to extract relevant geometric parameters that can distinguish figures drawn by different students. These are used to train the system. In the next step the scanned image to be verified is fed to the system. It is pre-processed and various features are extracted from them. These values are then compared with the mean features that were used to train the system. Depending on whether the input figure satisfies the threshold condition, the system either accepts or rejects the figure and grade accordingly. The steps involved in grading figures are

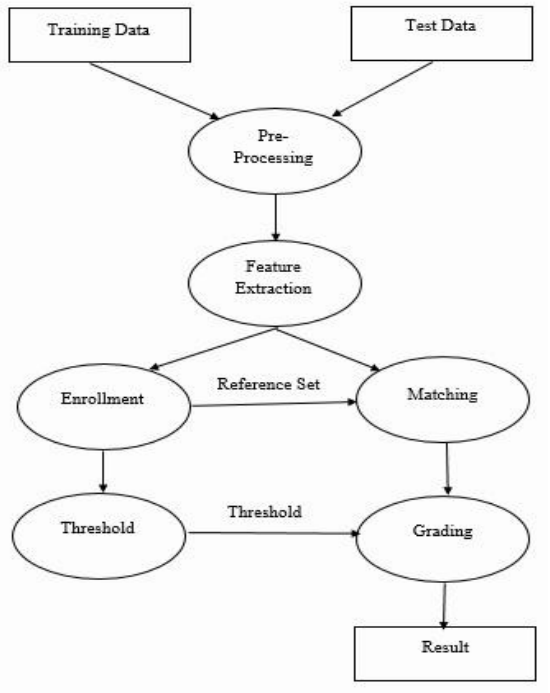

Fig. 3: Proposed method for grading figures

A. Training Data

Training data is the image used for training the entire system. This image is the reference image, which is used for comparing with the test image. The various features of the training data is used for the comparison.

B. Test Data

Test data is the image which is used to check the similarity with respect to the training data. The feature of the test image is compared with the features of training image. In this system, test image is the hand-drawn images of students.

C. Pre-Processing

The intensity histogram computation based approaches generally use two peaks for finding the threshold value, but many images do not have such two peaks in the histogram. For those hand-drawn images where the text written in input image is having more or less the same intensity value or written by a single pen. Basically it calculates a global threshold. After that the image is converted into binary with respect to the threshold value.

D. Text Recognition

Character segmentation and recognition is performed at this stage. According to Sayres Paradox, a letter cannot be segmented before having been recognized and cannot be recognized before having been segmented. So segmentation and recognition should work parallel with each other. In the segmentation stage, an image of each word received is decomposed into sub-images of individual characters. In Heuristic based segmentation, stroke width and height estimation are analyzed to segment words into its characters. Then character segmentation region is identified which computes the segmentation boundary between the connected characters. For both training and testing phases, a heuristic feature detection algorithm is used to locate prospective segmentation points in handwritten words.

E. Shape Recognition

Shape recognition includes recognition of basic geometrical objects using an algorithm that extracts information from the image at hand and makes decisions on the basis of a few metrics. For detecting the shape, Hough Transformations are used.

F. Enrolment

The first step in any training involves collection of data. The image containing the original figure (training data), against which the hand drawn image is verified, is pre-processed and stored. The enrolment stores the location of various text, shapes and connections in the image. This data is used for grading the figures drawn by students.

G. Matching

The image containing the hand drawn figure (test data) is pre-processed and stored. The location of various text, shapes and connections in the test image are collected. This data is used for comparison in the grading step.

H. Grading

Grading is the final step involved in the process evaluation of figures. The grading step compares the data collected from the test image w.r.t the data stored in the enrolment, which is collected from training data. The texts, shape of objects and connections have importance in the grading process. Each of these features has a certain weight, total weight is computed and the result is given as an input to the artificial neural network. The pre-trained network selects the grade corresponding to the input.

IV. EXPERIMENTAL RESULTS AND ANALYSIS

Hundred samples are collected from various students and evaluated. The experimental results are then compared with the results taken from different lecturers. The accuracy of the system is then calculated. From the hundred samples 10 samples are taken at random for showing the effectiveness of the system.

	Teacher A	**Teacher B**	**System**	**Avg. Mark**	**Error %**
Sample 1	10	9.5	10	9.75	2.5
Sample 2	10	9.5	10	9.75	2.5
Sample 3	10	9.5	8.33	9.75	14.2
Sample 4	9	8.5	6.67	8.75	20.8
Sample 5	9	8.5	6.67	8.75	20.8
Sample 6	9	8.5	8.33	8.75	4.2
Sample 7	9	8.5	8.33	8.75	4.2
Sample 8	10	9.5	8.33	9.75	14.2
Sample 9	8	8.5	6.67	8.25	15.8
Sample 10	4	5	5	4.5	5

Table 1: Accuracy Calculation

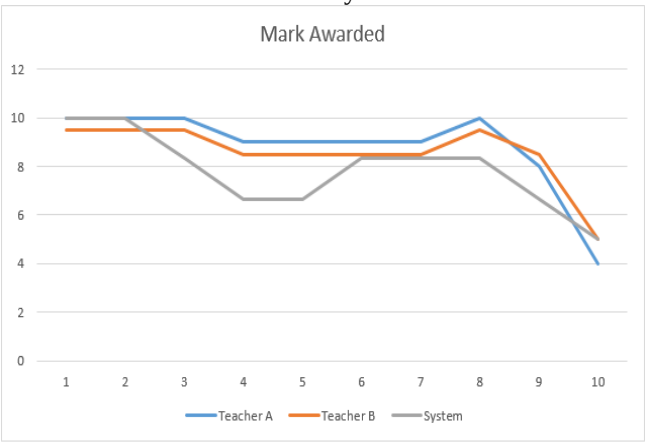

Fig. 4: Marks Awarded

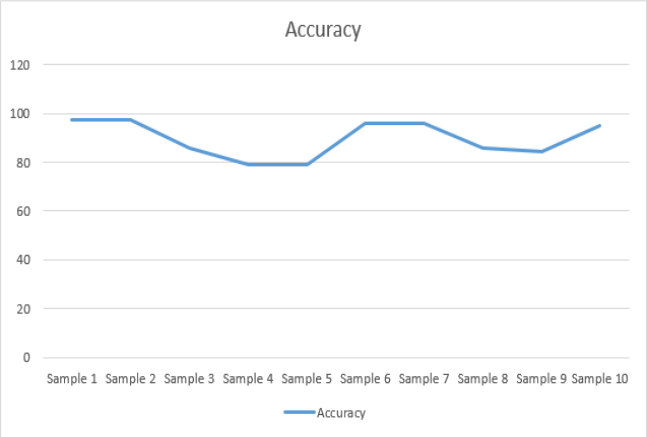

Fig. 5: Accuracy

Average % error = 83.4/10 =10.42%
Average accuracy of the system =100-10.42= 89.58%

V. CONCLUSION AND FUTURE ENHANCEMENTS

The system aims to make an automated system to evaluate student's hand drawn image which produces the grades and to check whether the system is effective similar to the manual evaluation method. The system evaluated the student's hand drawn images and verified the correlation with the manual evaluation of images. The texts and shapes that appeared in the images are extracted using image processing techniques. The grades are calculated by comparing with the original image. It also make use of Neural Network for analyzing the marks and publishing the appropriate grade. With the above results it can be concluded that with more reliable feature extraction technique and larger dataset for character and input samples, the result for the complete system can be further improved and enhanced. If the system's training for recognizing handwritten text and shape is improved, it can further improve its success rate to a very appreciable measures. More research on component segmentation and finding relationship between the components may help in making this system complete offline unconstrained hand-drawn image recognition and grading system. Moreover, it is possible to extend the use of these concepts to solve Image Plagiarism checking.

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