Optimization of Answer Sheet Evaluation Process Using Image Processing.

Ingole Sunil Keshavrao and Tejas Fulkar

Department of Computer Engineering

MET's IOE, Nashik

University of Pune

sunilpatilingole@gmail.com

fulkar.tj@gmail.com

***Abstract* — The paper presents the application of image processing for optimization of the current University/Faculty answer sheet evaluation. Optimization is the act, process, or methodology of making something (as a design, system, or decision) as fully perfect, functional, or effective as possible. The possible solution to the some of the drawbacks in the present evaluation procedure is presented and the algorithm for the same is defined. There are several processing methods for extracting the information from the images out of which the Optical Mark Recognition (OMR) is used in the solution system. The influence of the proposed system on the efficiency is commented at the end of the paper.**

***Keywords* -- Digital Image Processing, OMR, Region Extraction, Sub region Extraction, Reflectivity comparisons, Implementation and working.**

I. INTRODUCTION

The image processing is a branch of computer science in which the digital signal, representing a digital image taken by a digital camera, or generated by a digital scanner, is processed. The traditional approach of answer sheet evaluation is still continued till the present date. Though the OMR sheets are verified through scanning, the handwritten answer sheets cannot be evaluated by scanning them. With the increasing number of students and the addition of various internal and final University/Board exams, it is necessary to optimize the answer sheet evaluation process.

A. The Present Evaluation Scenario (Rough Overview)

The answer sheets are distributed among the various evaluators. Then each answer sheet is evaluated individually and then the corresponding details are entered into a database. This data entry process begins only after the answer sheets are evaluated, and considering the total number of answer sheets, the data entry process either requires a large manpower or consumes additional time. Then finally the mark sheets are produced with the help of the database marks.

B. Flaws in the Present Evaluation Process

There are some flaws present in the current evaluation process. These could be expanded as shown below.

1) Time Consuming: The data entry process consumes nearly same time as required for the paper checking. This ultimately increases the overall time cost of the entire process.

2) *Lack of Transparency:* The evaluated papers are not presented to the students and hence the result totally depends upon the database entry of marks. On demand Xerox copies are provided but at a higher cost and not along with the result. Thus the overall process is not transparent.

C. Proposed Optimization Measures

One of the possible measures to optimize the present scenario is the use of system which extracts the required details during the process of evaluation and saves these details into the database as with the completion in evaluation of each answer sheet. This would help to overcome the time issue. Also if the entire evaluation footage is captured for each individual answer sheet, then it could be uploaded along with the results, so as to bring a completely transparent system.

II. DIGITAL IMAGE PROCESSING

In general, all applications involving image processing can be sub categorized under two categories based on their main goals. Those concerns with development and extraction of information for human interpretation and understating, and those concerns with generating data for further machine interpretation. Any image processing, usually involves three steps. The first step is to import the image using an optical scanner or directly through a digital camera. The second step concerns with image manipulation including enhancement, noise reduction and compression of data. The final step is to generate an appropriate form of output, which could be simply a modified version of the source image or a sequence of character representing some data extracted from the processed image.

A. Digital Image

A digital image is a finite set of digital values representing a two dimensional image. These digital values or pixels, are stored in computer memory as a two dimensional array of integers. Each pixel represents a specific coordinate in a two dimensional region on the image and contains some information about that position. Digital images can be

classified according to the type of this information. For example a colour image is an image in which each pixel holds the information about the colour of the point it represents.

B. Display of Digital Image

An image represents a two-dimension illumination magnitude function *f (x, y)*, where *x* and *y* are location Coordination and in any point *(x, y)* the value of function *f* is proportional to the illumination or the Grey level of that point.

Fig.1a Use of conventional axis in displaying digital images

C. Image Processing Fundamentals

The first step toward processing an image to extract the information is called *Image Acquisition* which means acquiring the digital image either directly from a digital camera or by using an optical scanner or any other photography device capable of digitalization of the output signal.

Pre-processing is the second step. The main task in pre-processing is using different techniques to improve the quality of the image which increase the chance of success in later processing activities. Pre-processing normally involves techniques to adjust the contrast level, eliminate the existing noises and adjust the minor rotations. Rotations are usually fixed by taking two points which are supposed to be on a horizontal line and find the slope of the line between them. And then this slop will be considered in all arithmetic and calculations.

The next step is called *Segmentation.* This is the process of dividing the input image into its comprising segments or components. Segmentation is regarded as one of the most difficult tasks of image processing. The use of powerful and appropriate segmentation algorithms in this phase considerably increase the chance of overall success. And weak or erroneous algorithms almost always lead to dramatic failure.

The output of segmentation phase is normally rough pixel data which an area border or whole points inside it are recognized. This data should be formatted in an appropriate and proper way for computer processing. Hence one of the first decisions to make is whether the data should be displayed as a border or a whole area.

The border display is usually used where an external specification of the figure such as curves and corners are required. Whereas area display is preferred when some internal features and specification of the image segments such as image texture are required.

But in general there are two basic classes of models which are used to determine if an image satisfy some assumptions which is required in order for a particular technique to be applicable to it. *Statistical models*, that describe the pixel population in an image or region and *Spatial models* that describe the decomposition of an image into regions.

Description which is also called *feature selection* is concerns with extraction of features which gives some of the required quantitative information, or is fundamental to recognize something from other.

The final step consists of recognition and interpretation. Recognition is a process which, based on the obtained information from descriptors, assigns a label to an object. Interpretation consists of definition assignment to a set of recognized objects.

Knowledge and information about problem is kept in a database inside the image processing system. This knowledge may be simply some information about the location of the areas containing details of interest, or might contains a more complex set of information.

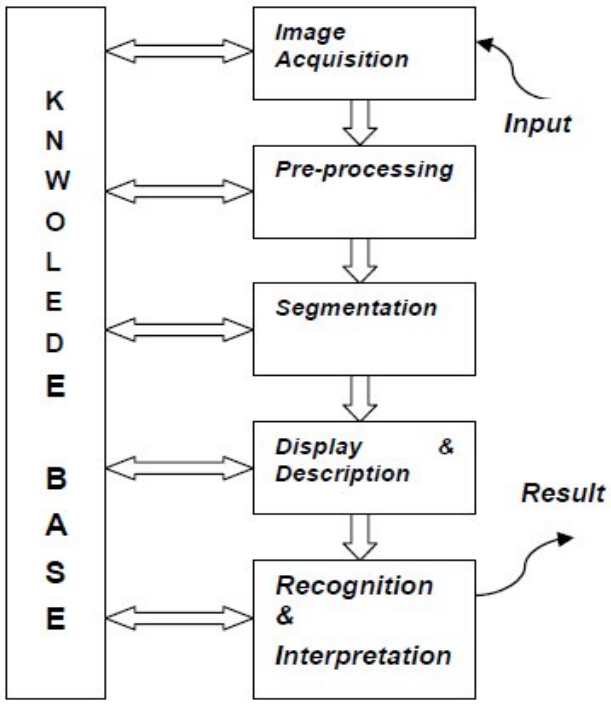

Fig. 1b Image processing life cycle

D. Components of System

In general the basic components of every image processing system are:

1) Image Acquisition device:

Digital camera

Optical Scanner

2) Storage unite:

Optical Disc

Video Tape

Magnetic Disc

Magnetic Tape

3) Processing device:

PC computer

4) Communication and Display:

Television Display

Printer

Photography film

III. WORKING

A. Identification Components

The efficient identification of the following components is essential for proper optimization:

- Seat Number - It will be identified from the first page of the main answer sheet and signal for the commencement of the video capturing. The video footage will be saved with the seat number as parameter name to distinguish videos.
- Page Total- These will be identified and stored in a variable. Each time this variable will be incremented to obtain the total.
- Total Marks- This will appear on the first page of answer sheet. The computer will match the marks written by the evaluator with the marks stored in variable and once both are verified then the marks will be directly saved into the database along with seat number and other required details. The recording will be stopped after the marks verification is done.
- Page Numbers- The need to identify the page numbers is to avoid the repetitively image processing over the same page again and again. Once a page total is obtained then that page need not be processed again for the page total.
- Optional marks- If an optional question is included in the page total then such marks need to be reduced from the total marks and thus they need to be identified.

The identification of these components could be done by using any one of the image processing methods namely OCR, ICR and OMR. Since OCR and ICR for handwritten characters lacks accuracy, this paper presents the working based on OMR over a sample answer sheet.

B. OMR (Optical Mark Recognition)

Optical Mark Recognition is a method of capturing information by comparing reflectivity at some predefined coordination on an image. This technology is used for finding and recognising a mark on an image. Based on predefined forms, an OMR system is capable of storing and retrieving information from the form and analysing them. This is a method which is used widely in industry and universities. Usually this method is combined with other processing method to provide a powerful tool for processing forms.

Optical Mark Recognition involves the identification of the sub-regions and the regions containing these sub-regions. Sub-regions may be in the form of rectangles, circles or some predestined area and the region may be the area in which these sub-regions are present. Sub-region is considered to be marked if it is filled or crossed. Filling may be partial or complete but understandable. A marked sub-region conveys the associated information which is then converted into internal data for further processing. For this purpose the position (coordinates) are calculated and the reflectivity is compared with the predefined coordination to obtain the associated information.

Some of the key benefits of OMR system which make it suitable for a wide range of activities are:

- Capability of controlling and modifying forms.
- Cost reduction.
- Easy to use in office/home.
- Fast rough data processing.
- Obtaining results and analyzing data are fast and easy.
- Easy back up and support through the network.
- Fast and easy installation.
- No need for skill to use.
- Reduction of human resources.

C. Answer sheet format requirement

The OMR requires specially designed answer sheets with predefined coordination. Consider the following sample answer sheet with the variations in the First (Title) Page and the inner pages as shown in Fig. 2a and Fig. 2b. The sample answer sheet is designed according to the Engineering Examinations conducted by the University of Pune. It could be generalized by little modifications but the cost for software processing increases and the accuracy of the system reduces due to the reduced scope for reflectivity comparisons of closely spaced sub-regions. Thus it is recommended to make the use of specialized answer sheets rather than generalized form of OMR answer sheets.

Fig 2a represents the Front or the Title page of the answer sheet containing he major details which include the Seat number, Total marks and the Question Wise marks. The page numbers are numbered according to binary notations as shown which consists of sub-regions in the form of circles which are filled according to the binary notation. All the sub-regions on the title page are circular which will be considered as marked when filled partially or completely. The regions are the

predefined coordination for the corresponding components. The seat number is of 8 characters consisting of 1alphabet and 7 digits. Here F, S, T, B represents the F.E., S.E., T.E., B.E. examination. Also the maximum marks that could be obtained in the subject is considered to be 50. The answer sheet provides the space for the allotment of marks for six distinct questions namely Q1 to Q6 for section number 1 and Q7 to Q12 for the section number 2. Each question can be allotted a maximum of 16 marks respectively.

Fig 2b represents the sample format of the remaining pages of the answer sheet. The regions to be identified include the region for page number which is same as that of the title page and the page total which is identified with the predestined area of the page. Note that here the maximum page total that can be identified is 16, when the sub-region 1 is marked from 1st row and the sub-region 6 is marked from the 2nd row. It is designed such considering that each question carries maximum marks of 16 and each new question should start on a new page as in case of University of Pune.

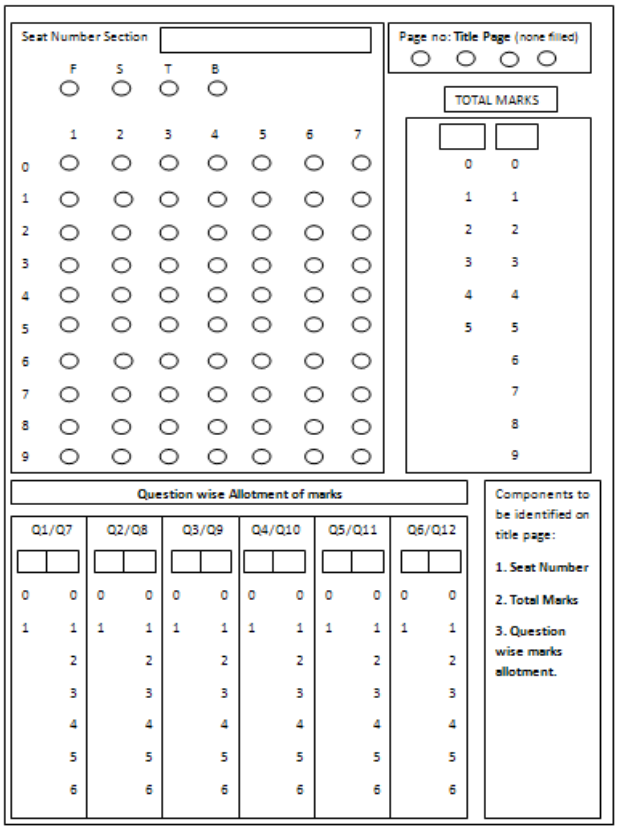

Fig. 2a Front (Title) page of the sample answer sheet

Although the constraints can be generalized, a specialized approach helps to provide a more understandable solution that maximizes the optimization level. The same answer sheet sample can be varied against the mentioned constraints as per the requirement. Note that the predestined regions in the answer sheet are the varied positions of the components to be identified. The page number always lies in at the top-right corner which makes the segmentation process easier. In case of supplements attached to the paper the title page of the supplement should represent the next binary number of the last page of the answer sheet.

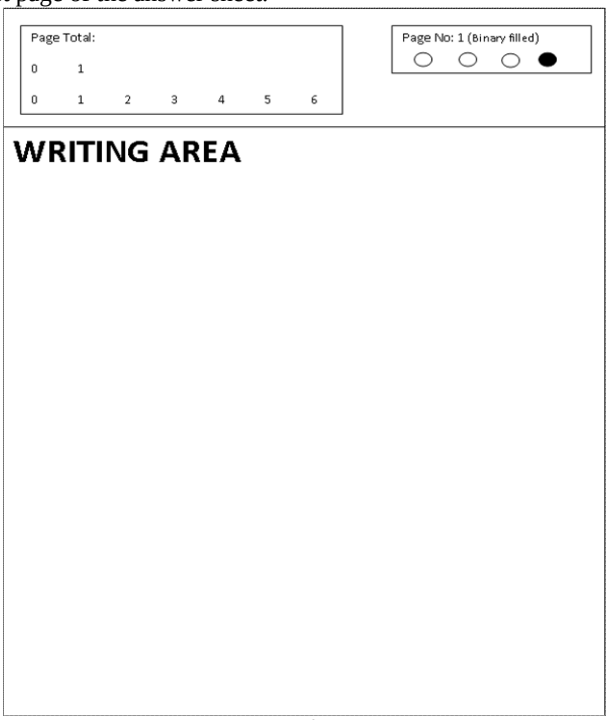

Fig. 2b Remaining pages of the sample answer sheet

C. Working and System Flow

The working and the system flow that is the flow for the activities in the proposed system are as follows-

1) Authentication and Validation: This is the most primary step for checking whether the evaluator is valid and permissible to for the evaluation process. The Administrator of the corresponding University or any Authoritative Personnel has the right to edit the database of the evaluators. The evaluator enters the Subject name and the Section Number in the second phase of the login. The evaluator can now command the machine to start the video and image processing activity.

2) Seat Number Identification: After the start of the video capturing, the seat number identification is the first image processing activity that is performed. The seat number is validated and is confirmed by the evaluator before saving the details into the database.

3) Page Number identification: The page numbers represented using the binary representations are identified to obtain the region of interest. For the title page the region of interest is the Total Marks whereas for the remaining pages the region of interest is the Page Total.

4) Page Total Identification: While it is not the title page, page totals are indentified. The inner pages are virtually divided using segmentation into left and right pages. The sub-regions are identified with the help of the color ink (usually red) used by the evaluators. Once the page total is obtained the

corresponding page is marked as visited to avoid the repetitive processing over that page.

5) Total Marks Identification: When it is the title page the total marks if entered are identified and verified with the sum of the page totals. If the verification is successful the final confirmation is obtained from the evaluator else the question wise marks are identified to check for the optional question attempted so as to reduce the sum of page totals accordingly.

6) Question Wise marks Identification: These are identified to calculate the marks allotted for optional questions. The total marks are once again verified and if successful then final confirmation is demanded from the evaluator else an "Total Mismatch" error message is popped out to the evaluator.

7) Confirmation for Database Entry: It confirms the details that are going to be saved into the database for the further processing. It includes the Seat Number, Subject, Section and Total marks. Once confirmed the video capturing is stopped and saved at the destination using seat number, subject and section parameters. The other section of the evaluated paper if already present in the database then the combined total is stored in another results database containing individual student results. Thus all the manual data entry work is automated.

IV. CONCLUSIONS

The flaws/drawbacks of the present evaluation process can be overcome and the proposed system promises the optimization providing the following advantages:

A. Time efficient: As the data entry is automated the corresponding time is saved. Also a student gets to know about his/her paper evaluation details so that he/she can think over rather than wasting time in the process of revaluation.

B. Transparency: This system provides complete transparency for the paper evaluation process. No one can question about the working of the evaluation process.

C. Reduced cost for students: The videos can be downloaded by the students, the cost for on demand Xerox answer sheets are reduced. Also it gives a chance to think over for the students whether to opt for revaluation or not, thus reducing the cost of revaluation.

D. Total Marks verification: The calculation errors are overcome due to the total verification. Since this is carried out during live run-time evaluation process, it prevents the calculation error to be propagated in further stages.

TABLE I
EXISTING AND PROPOSED SYSTEM COMPARISON

Sr. No.	Comparison Factor	Existing System	Proposed System
1	Data Entry	Manual	Automated
2	Transparency	comparatively less	Maximum
3	Total Marks verification	Manual	Automated
4	Additional Requirements	No	Yes
5	Cost for system	Less	More
6	Cost for students	More	Less
7	Accuracy	Evaluator dependent	Machine Monitored
8	Efficiency	Less	More

The proposed optimization ensures the well-being of University as well as the student and provides a new approach in evaluation process with more efficiency.

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