

Digital Doc

Optical mark recognition

Tallying information from filled-in 'bubbles'

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VOL 104 / NO 2 / AUGUST 1998 / POSTGRADUATE
MEDICINE

One of the greatest medical challenges outside of the diagnostic process is keeping accurate and complete records. Clinicians may spend 30% or more of their time fulfilling documentation requirements. Granted, many of these requirements are necessary, but they exact a toll on clinical and administrative staff and reduce the time available to patients.

Information technology is often viewed as a means of reducing paper shuffling. Ironically, though, it may save time and effort, but without affecting the paper load. Despite the best intentions of computer manufacturers, paper seems to be here to stay. Paper has a lot going for it. It's inexpensive, ubiquitous, easy to copy, and the epitome of portable. It doesn't even require batteries. Often, paper forms are simply the best means of acquiring data. The challenge is getting that data into a machine-readable format so it can be manipulated and analyzed.

Our problem

In an effort to revamp its quality-assurance program, the Department of Anesthesiology at Massachusetts General Hospital, Boston, requires that staff members complete a two-page incident report, consisting of check-off boxes, after each procedure. At first, a full-time administrative assistant had to manually key in report results to create a database and summary report. Since the department generates about 2,000 reports per month, the assistant not only fell behind in the keying-in process but also got tired of the mind-numbing task. In this age of information technology, we knew there must be a better way.

Our initial thought was to computerize the incident report and require staff and residents to enter findings at a clinical workstation. However, since compliance with reporting has never even *approached* 100% despite our best efforts, we

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feared that the delays of logging on and off and opening the appropriate application would further reduce compliance.

With the goals of decreasing turnaround time and load on our administrative assistant without increasing the documentation burden on our staff, we began exploring optical mark recognition (OMR) systems.

The technology

In simplest terms, OMR technology can read marks that have been made in predefined positions (eg, "bubbles" to be filled in, boxes to be checked off) on paper forms. It can be contrasted with optical character recognition (see Digital Doc, March 1998, page 37), which turns images of laser-printed characters into machine-readable characters, and intelligent character recognition, which translates handwritten characters into machine-readable characters. OMR is simple, reliable, fast, and flexible. No special training is needed to use the paper forms, and the automatic-reading process eliminates keying-in errors and greatly reduces clerical and turnaround time. Accuracy of most OMR systems approaches 100%, versus about 98% for optical character recognition and 95% for intelligent character recognition.

If you've ever taken a standardized exam, such as the Medical College Admissions Test, you've had firsthand experience with traditional OMR forms. I still remember my admissions test sheets: crisp and white with numbered rows of pink ovals that seemed to stretch on endlessly, waiting for me to darken the appropriate ones with a No. 2 pencil. While traditional, dedicated OMR systems using special forms are still popular, especially in academic testing situations, they're expensive and cumbersome. For example, in a clinical setting, trying to handle both a key or questionnaire sheet and an answer sheet is difficult. Custom-designed forms with questions adjacent to bubbles or boxes are a possibility, but changes require printing new forms, which generally have to be ordered in sets of 500 or more.

Our solution

Fortunately, there is a new generation of OMR technology. Like traditional OMR systems, new systems read marks on forms. But unlike old systems, which require a special, expensive scanner, new systems use a relatively inexpensive general-purpose desktop scanner equipped with a sheet feeder. Using your own laser printer, you can custom-design forms and layouts.

However, throughput is limited by the speed and capacity of your scanner and sheet feeder. Our system (Remark Office OMR 4.0 and a Hewlett-Packard 4c flatbed scanner and standard sheet feeder) reads about 10 pages per minute. That's pretty good compared with the 1 page per minute required for manual inputting. But it's only fair compared with the 30 pages per minute achievable with a high-end general-purpose scanner and sheet feeder. And it's downright dismal compared with the 100 pages per minute a high-end dedicated OMR scanner can handle. But our system's throughput is more than sufficient for our needs.

Our system cost about \$400 for the OMR software and \$1,000 for the scanner and sheet feeder. It has turned out to be a good investment. The system recognizes bar codes, processes multipart forms, and collates double-sided forms.

Creating new forms is only a bit more complicated than editing or creating a Microsoft Word document. Supply costs are low because the system takes ordinary paper, and the general-purpose flatbed scanner can also be used for graphics and optical character recognition work.

Getting started

Once you've set up your scanner and installed the OMR software, working with forms is relatively straightforward. If you don't have an existing form, the first step is to design one using any graphics or word processing package you like. Then use the OMR software to design a template defining where on the form the software should look for answers and how the bubbles or boxes should be grouped logically for data entry (eg, with six rows of four check-boxes, each of the six rows would be a separate entry).

Once you start scanning completed forms, you'll probably encounter "conflicts" (eg, questions with no or more than one answer selected). Such problems can be resolved as pages are read (eg, indicate with the mouse any selections that are visible on the screen but too light to be read automatically), but it's often more efficient to deal with them after all the forms are scanned.

Finally, you'll have to decide how to save and analyze the data. Output options range from simple text to database formats, such as Microsoft Access. When it comes to analysis, some OMR programs compile frequency distribution, number of responses, median and range, and similar basic statistics automatically. Remark Office OMR provides automatic graphing of summary data. Various stand-alone visualization and statistical tools, such as Microsoft Excel, also can be used to interpret and display data.

Not everything to everyone . . .

Despite all it has going for it, OMR isn't foolproof. Poorly designed forms can be extremely arduous to complete. And if more than a few dozen bubbles or boxes must be filled in, the data-entry load quickly becomes overwhelming. For example, recording patient names and hospital IDs would probably be easier using a bar code label than a fill-in form.

Staff members can lose the forms, spill any number of liquids on them, sit on them, or otherwise make them unsuitable for scanning. Unlike computer-based forms that check data as they are recorded, OMR systems always carry the potential for errors of omission and double entry. With double-sided forms, unless you choose a relatively heavy paper stock, entries on one side of the form can bleed through to the other side and inadvertently darken a bubble. Staples and sheet feeders don't mix, and unnumbered multiple-page forms can be scanned in the wrong order.

. . . but quite a lot to quite a few

I've found that, although the new generation of OMR isn't a panacea for every medical data -capture problem, it's certainly catching on. It seems that whenever a group within our department hears of a successful OMR application, a different group comes up with yet another use. Current ideas include using OMR to capture preadmission workups,

staff feedback and reporting, history and physical exam data, speaker evaluations, and patient-satisfaction surveying. I'm sure that if this technology were available in your clinic or department, you and your staff would discover many innovative and useful applications for it.

To learn more about Remark Office OMR 4.0

How it works:

<http://www.spss.com/software/spss/base/Remark/rmkwork.html>

Specific information: Principia Products Inc, 16 Industrial Blvd, Suite 102, Paoli, PA 19301; phone, 800-858-0860, 610-647-7850; technical support, 610-647-8595; fax, 610-647-8771; <http://www.principiaproducts.com/>

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