An Inexpensive Braille Terminal Device

GARY B. ANDERSON AND DAVID W. ROGERS
Lawrence Radiation Laboratory, University of California, Livermore, California

The active use of time-shared facilities for blind programmers requires a braille terminal system. Details are given for the construction of a brailler from a model 33 teletype by modifying the print head and increasing the resiliency of the platen. A description of the programming needed to drive the brailler is presented.

KEY WORDS AND PHRASES: blind communication, blind programming aid, braille, braille computer communication, braille output, braille teletype, braille terminal, braille type head, embosser, tactile computer communication, tactile teletype, tactile terminal
CR CATEGORIES: 4.41, 6.35

Introduction

Professional programming as an occupation has been shown to offer to the blind the unique opportunity of being able to compete with sighted programmers [1]. Most of the problems that occur are with the communication between programmer and machine. These have been solved in the past by: (1) building special devices which enable the blind to read cards and inspect the operating console; (2) writing special programs which can use existing printer-computer facilities to convert standard output into braille listings; and (3) by devising methods for the blind to produce cards or programming sheets. The solutions proposed have generally been aimed at the small computing center or batch processing installation where the programmer can gain physical access to the machine.

With the introduction of time-sharing, availability of the line printer and main console for special purposes has decreased to a low level, thus making it difficult for the blind to have proper machine communication with available techniques. It is also desirable that the blind have time-sharing access to the machine. The proper solution is to design a remote console which will accept suitable input from the user (typewriter keyboard) and respond with some form of braille. With a device of this type a blind programmer has virtually no disadvantages compared with a sighted programmer. A remote console gives the blind user the added advantage of being able to work in his office, thus relieving him from commuting to the computer center.

Several methods of constructing a terminal unit have been considered. The first is to use a small computer or hardware device to drive an electrified braille punch. The second is to modify a paper punch to produce braille patterns on paper tape either by punching or embossing. A third approach is to modify existing equipment (model 33 teletype) to emboss braille on standard roll paper. The second and third methods can use the time-shared computer to do the character conversion needed to produce braille. The first method has the advantage that little or no programming is necessary, and the disadvantage of high hardware cost. The use of a paper punch is simple and inexpensive, but it produces poor quality braille in a bad format (tape). The existing equipment approach has the following advantages: (1) it is inexpensive; (2) it can be accomplished so that the equipment is reusable for its normal function; and (3) it produces braille comparable in size and quality with standard braillers. For our installation this last method is best, considering cost and quality at the expense of programming.

Work performed under the auspices of the US Atomic Energy Commission.

Remote Brailler

A model 33 teletype has been modified to emboss the seven possible braille columns. Each column is composed of from one to three dots in a vertical format. Two braille columns are required to form one braille character. This unit is driven through the time-sharing system by a program which converts each teletype character into two characters: the first represents the left half of the braille character; the second represents the right half. Each braille character is separated from the following character by a space. Vertical line spacing is accomplished through program control. Each full line (72 characters) is embossed as nine lines (three braille lines). The braille output is read by folding the paper forward over the teletype and hand scanning from left to right, bottom to top.

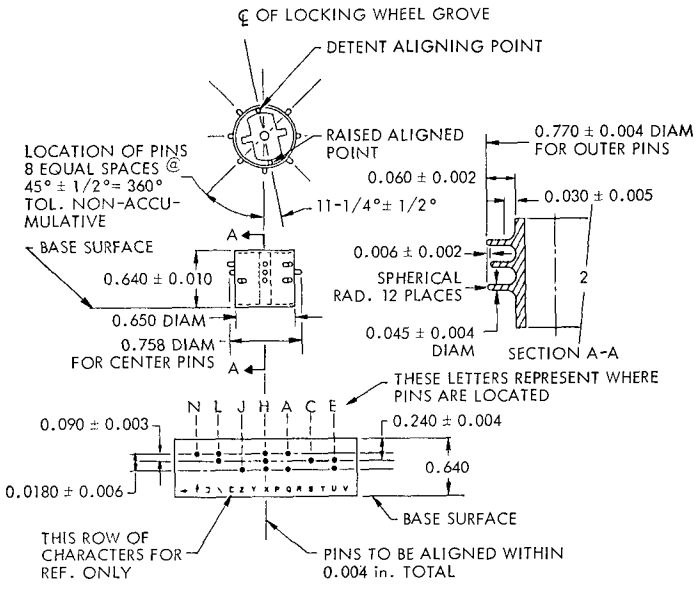

FIG. 1. Details of braille wheel

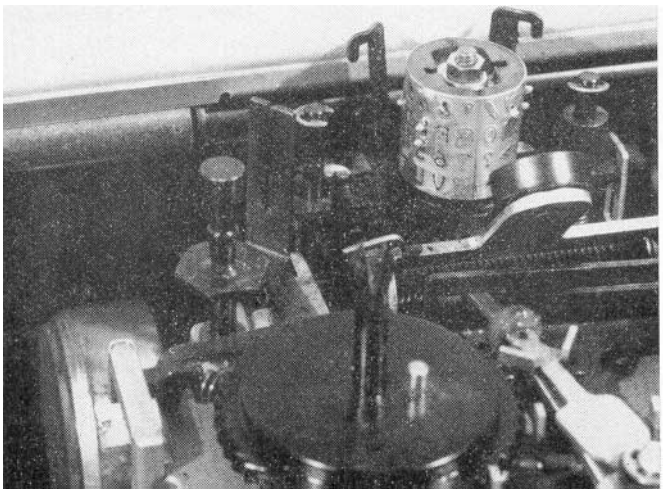

FIG. 2. Braille wheel installed

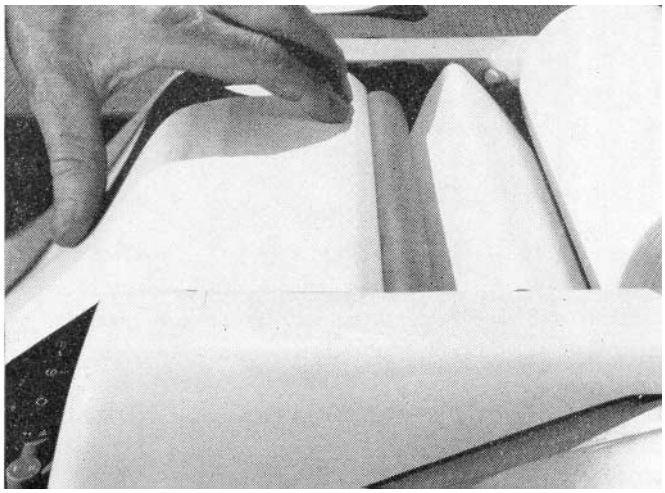

FIG. 3. Reading position of teletype braille

Teletype Modifications

The following modifications have been made to the model 33 teletype (none of these prevents the return of the unit to the production of standard output):

1. The teletype print wheel has been modified (Figures 1 and 2) to emboss the seven braille columns. This was accomplished by removing the type from the wheel and inserting pins. Each pin corresponds to one braille dot. To prevent extraneous dots from appearing, the braille columns are placed in alternate type positions on the wheel. All columns are positioned on the same vertical level. The extension of the pins beyond the surface of the wheel has been adjusted to account for the resiliency of the platen, the force of the hammer, and the curvature of the platen.
2. The teletype platen has been covered by a length of surgical rubber tubing 1 in. in diameter and $\frac{1}{16}$ in. thick. This provides the backing necessary to easily emboss the braille dots without perforating the paper.
3. The ribbon has been removed.
4. The edge of the plastic window has been bent down toward the platen to allow the braille line to be read two lines after it has been formed (Figure 3). This modification is not necessary, but it is a convenience to the reader.
5. The wire paper guide in front of the platen has been removed to provide room for modification 4.

If the user is willing to wait a little longer (four braille lines) before reading a braille line, modifications 4 and 5 can be eliminated. Then given a braille wheel and the rubber backing, any teletype can be converted to a brailler in a few minutes.

The braille teletype has not been in use at our installation long enough to determine the long-range effects of these modifications upon the reliability of the teletype. Our initial experience indicates that the short-term reliability is similar to that of an unmodified machine.

Programming

The program needed to drive the brailler is a simple character converter. It converts each internal character into the teletype characters which correspond to the left and right braille columns (Table I) and then follows these characters with a blank. These characters are then transmitted instead of the original. Note that the braille columns are inverted with respect to the way they will appear in the output. This is due to the inversion of the braille

(*Please turn to page 440*)

TABLE I. TELETYPE CHARACTER SUBSET WITH BRAILLE REPRESENTATION AND BRAILLER LEFT AND RIGHT COLUMN EQUIVALENTS

Character	A	B	C	D	E	F	G	H	I	J	K	L	M
Braille	⠁	⠃	⠉	⠙	⠑	⠋	⠛	⠓	⠊	⠚	⠅	⠇	⠍
Equivalent	JG	EG	JJ	JE	JC	EJ	EE	EC	CJ	CE	AG	HG	AJ
Character	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
Braille	⠝	⠕	⠏	⠟	⠗	⠎	⠞	⠥	⠧	⠺	⠭	⠽	⠵
Equivalent	AE	AC	HJ	HE	HC	LJ	LE	AN	HN	CH	AA	AH	AL
Character	1	2	3	4	5	6	7	8	9	¢	(	)	*
Braille	⠁	⠃	⠉	⠙	⠑	⠋	⠛	⠓	⠊	⠚	⠈⠅	⠈⠇	⠈⠍
Equivalent	CG	LG	CJ	CL	CN	LC	LL	LN	NC	NL	HL	LH	JN
Character	-	+	.	ↄ									
Braille	⠤	⠖	⠲										
Equivalent	NN	NA	GA	GG									

```
        tion is unbounded", for example, the statement outstring (1, 'primal problem has no feasible solutions, dual objective function is unbounded');
      go to LAST
    end else go to R
  end
end
else
begin
  if L = 2 then
  begin
    if k = 1 then
    begin
      for i := 2 step 1 until m + 1 do
      begin
        if e[i, ind[1]] > 0 then go to C
      end;
      comment Insert an output statement to print "primal objective function is unbounded, dual problem has no feasible solutions", for example, the statement outstring (1, 'primal objective function is unbounded, dual problem has no feasible solutions');
      go to LAST
    end else go to S
  end;
  if k = 1 then go to C else go to S
end;
R: prophi; rowtrans(imax, jm); go to RCS;
C: progamma; rowtrans(im, jmin); go to RCS;
S: progamma; prophi;
  if gmin = 10^6 then
  begin
    rowtrans(imax, jm); go to RCS
  end;
  if phimax = - 10^6 then
  begin
    rowtrans(im, jmin); go to RCS;
  end;
  if abs(phimax) > abs(gmin) then rowtrans(imax, jm)
  else rowtrans(im, jmin);
  go to RCS;
LAST: end MINIT
```

ANDERSON AND ROGERS—cont'd from page 418

characters as the paper is moved forward over the teletype to be read. The conversion routine also supplies a carriage return and three line feeds at the end of each braille line.

There are two techniques for using a conversion program in conjunction with a time-sharing system. The first method is to embed the conversion routine directly in the system operational programs (teletype driver programs). This has two advantages: (1) the user can have braille communication with any existing program without making any special provisions for braille; and (2) all of the system messages are translated into braille. Unfortunately, adding specialized routines for particular input-output devices is quite inconvenient. The second method is to incorporate the conversion program as part of a particular program (compiler, editor, object program). This is an easy task and allows the user direct access to a conversational program at the expense of incorrectly printing operating system messages. We selected the second method because we wished to implement the braille system with the least programming effort.

Improvements

When operating the teletype in the simplex mode it would be advantageous to have some method of disconnecting the keyboard from the printer. In the present simplex system a braille column which has no meaningful relationship to that character is printed as each character is typed. After a complete message has been typed in, the system echoes it in braille. Elimination of the nonmeaningful columns would give the user a complete braille copy of his conversation with the machine.

Some inexpensive method to collect paper at the front of the machine, such as a motor driven takeup spool, should be devised, as the paper falling forward over the front of the teletype interferes with the use of the keyboard, and therefore the paper must be torn off at short intervals.

Conclusions

The operation of the modified teletype brailler has proved to be very effective. The braille produced is easy and convenient to read. Hardware modifications and programming are found to be easy and inexpensive. Reliability of the overall system approaches that of a nonbraille system. With the exception of a few system messages, a blind programmer has complete access to conversational programs to which the character conversion has been added.

Acknowledgments. The authors express their appreciation to Dr. J. R. Slagle, W. C. Wilson, J. R. Sypolt, and S. S. Nakano for their help in the design, production, and testing of the original device.

RECEIVED MAY, 1967; REVISED OCTOBER, 1967

REFERENCE

1. STERLING, T., LICHSTEIN, M., SCARPINO, D., AND STEUBING, D. Professional computer work for the blind. *Comm. ACM 7*, 4 (Apr. 1964), 228–230, 251.