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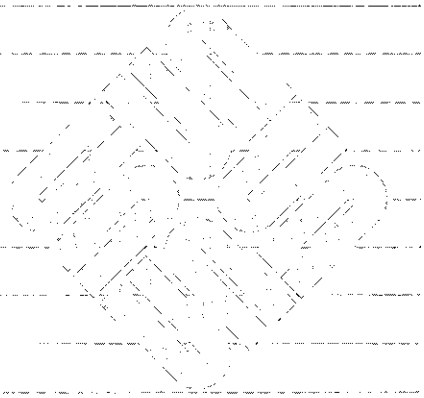
Programmer's Reference Manual *for* Curses on the Sun Workstation



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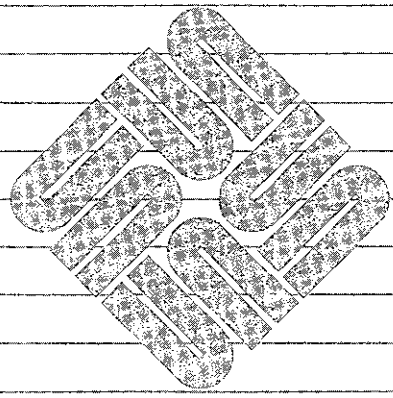

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Acknowledgements

This manual was derived from the paper entitled ***Curses — A Screen Updating and Cursor Movement Library Package*** by Ken Arnold, University of California at Berkeley.

This package would not exist without the work of Bill Joy, who, in writing his editor, created the capability to generally describe terminals, wrote the routines which read this database, and, most importantly, those which implement optimal cursor movement, which routines were simply lifted nearly intact. Doug Merritt and Kurt Shoens also were extremely important, as were both willing to waste time listening to Ken Arnold rant and rave. The help and/or support of Ken Abrams, Alan Char, Mark Horton, and Joe Kalash, was, and is, also greatly appreciated.

Revision History

Rev	Date	Comments
A	15 May 1985	First release of this Programmer's Reference Manual in the Sun documentation package.

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Chapter 1

Introduction

CURSES is a Library Package for:

- ***Updating a screen*** with reasonable optimization,
- ***Getting input from the terminal*** in a screen-oriented fashion, and
- ***Moving the cursor*** optimally from one point to another, independent of the two previous functions.

These routines all use the ***termcap*** database to describe the capabilities of the terminal.

1.1. Overview

In making available the generalized terminal descriptions in ***termcap***, much information was made available to the programmer, but little work was taken out of one's hands. CURSES helps the programmer perform the required functions, those of movement optimization and optimal screen updating, without doing any of the dirty work, and (hopefully) with nearly as much ease as is necessary to simply print or read things.

The CURSES package is split into three parts:

1. Screen updating without user input;
2. Screen updating with user input; and
3. Cursor motion optimization.

It is possible to use the motion optimization without using either of the other two, and screen updating and input can be done without any programmer knowledge of the motion optimization, or indeed the ***termcap*** database itself.

1.2. Terminology

In this document, the following terminology is used with reasonable consistency:

Table 1-1: Description of Terms

Term	*Description*
window	An internal representation containing an image of what a section of the terminal screen may look like at some point in time. This subsection can either encompass the entire terminal screen, or any smaller portion down to a single character within that screen. Note that the term ***window*** is used elsewhere in the Sun system manuals when describing the window management packages for driving the bitmapped screens. CURSES windows bear little, if any, resemblance to the window system concepts.
terminal	Sometimes called ***terminal screen***. The package's idea of what the terminal's screen currently looks like, that is, what the user sees now. This is a special ***screen***:
screen	This is a subset of windows which are as large as the terminal screen, that is, they start at the upper left hand corner and encompass the lower right hand corner. One of these, ***stdscr***, is automatically provided for the programmer.

1.2.1. Cursor Addressing Conventions

The CURSES library routines address positions on a screen with the ***y*** coordinate first and the ***x*** coordinate second. This follows the convention of most terminals that address the screen in ***row***, ***column*** order. The reader should note this convention.

1.3. Compiling Things

To use the CURSES library, it is necessary to have certain types and variables defined. Therefore, the programmer must have a line:

```
#include <curses.h>
```

at the top of the program source. The header file <***curses.h***> needs to include <***sgtty.h***>, so one should not do so oneself[1].

Also, compilations should have the following form:

```
tutorial% cc [ C-compiler options ] filename ... -lcurses -ltermlib
```

[1] The screen package also uses the Standard I/O library, so <***curses.h***> includes <***stdio.h***>. It is redundant (but harmless) for the programmer to include <***stdio.h***> too.

1.4. Screen Updating

To update the screen optimally, it is necessary for the routines to know what the screen currently looks like and what the programmer wants it to look like next. For this purpose, a data type (structure) named *WINDOW* is defined which describes a window image to the routines, including its starting position on the screen (the (y, x) coordinates of the upper left hand corner) and its size. One of these (called ***curscr*** for ***current screen***) is a screen image of what the terminal currently looks like. Another screen (called ***stdscr***, for ***standard screen***) is provided by default to make changes on.

A window is a purely internal representation. It is used to build and store a potential image of a portion of the terminal. It doesn't bear any necessary relation to what is really on the terminal screen. It is more like an array of characters on which to make changes.

When one has a window which describes what some part the terminal should look like, the routine `refresh()` (or `wrefresh()` if the window is not ***stdscr***) is called. `refresh()` makes the terminal, in the area covered by the window, look like that window. Note, therefore, that changing something on a window ***does not 'change the terminal'***. Actual updates to the terminal screen are made only by calling `refresh()` or `wrefresh()`. This allows the programmer to maintain several different ideas of what a portion of the terminal screen should look like. Also, changes can be made to windows in any order, without regard to motion efficiency. Then, at will, the programmer can effectively say 'make it look like this,' and let the package worry about the best way to do this.

1.5. Naming Conventions

As hinted above, the routines can use several windows, but two are automatically given: ***curscr***, which knows what the terminal looks like, and ***stdscr***, which is what the programmer wants the terminal to look like next. The user should never really access ***curscr*** directly. Changes should be made to the appropriate screen, and then the routine `refresh()` (or `wrefresh()`) should be called.

Many functions are set up to deal with ***stdscr*** as a default screen. For example, to add a character to ***stdscr***, one calls `addch()` with the desired character. If a different window is to be used, the routine `waddch()` (for **window-specific** `addch()`) is provided[2]. This convention of prepending function names with a '**w**' when they are to be applied to specific windows is consistent. The only routines which do ***not*** do this are those to which a window must always be specified.

To move the current (y, x) coordinates from one point to another, the routines `move()` and `wmove()` are provided. However, it is often desirable to first move and then perform some I/O operation. To avoid clumsiness, most I/O routines can be preceded by the prefix '**mv**' and the desired (y, x) coordinates then can be added to the arguments to the function. For example, the calls

```
move(y, x);
addch(ch);
```

[2] Actually, `addch()` is really a **#define** macro with arguments, as are most of the "functions" which deal with ***stdscr*** as a default.

can be replaced by

```
mvaddch(y, x, ch);
```

and

```
wmove(win, y, x);
waddch(win, ch);
```

can be replaced by

```
mvwaddch(win, y, x, ch);
```

Note that the window description pointer (***win***) comes before the added (y, x) coordinates. If such pointers are needed, they are always the first parameters passed.

Chapter 2

Variables

Many variables that describe the terminal environment are available to the programmer. They are:

Table 2-1: Variables to Describe the Terminal Environment

Type	*Name*	*Description*
`WINDOW *`	`curscr`	current version of the screen (terminal screen).
`WINDOW *`	`stdscr`	standard screen. Most updates are done here.
`char *`	`Def_term`	default terminal type if type cannot be determined
`bool`	`My_term`	use the terminal specification in ***Def_term*** as terminal, irrelevant of real terminal type
`char *`	`ttytype`	full name of the current terminal.
`int`	`LINES`	number of lines on the terminal
`int`	`COLS`	number of columns on the terminal
`int`	`ERR`	error flag returned by routines on a fail.
`int`	`OK`	error flag returned by routines when things go right.

There are also several **#define** constants and types which are of general usefulness:

reg storage class 'register' (for example, `reg int i;`)

bool boolean type, actually a 'char' (for example, `bool doneit;`)

TRUE boolean 'true' flag (1).

FALSE boolean 'false' flag (0).

Chapter 3

Programming Curses

This is a description of how to actually use the screen package. In it, we assume all updating, reading, and so on, is applied to ***stdscr***. All instructions will work on any window, by changing the function name and parameters as mentioned in chapter 1.

3.1. Starting up

To use the screen package, the routines must know about terminal characteristics, and the space for ***curscr*** and ***stdscr*** must be allocated. These functions are performed by `initscr()`. Since it must allocate space for the windows, it can overflow core when attempting to do so. On this rather rare occasion, `initscr()` returns ERR. `initscr()` must ***always*** be called before any of the routines which affect windows are used. If it is not, the program will core dump as soon as either ***curscr*** or ***stdscr*** are referenced. However, it is usually best to wait to call it until after you are sure you will need it, like after checking for startup errors. Terminal status changing routines like `nl()` and `crmode()` should be called after `initscr()`.

Now that the screen windows have been allocated, you can set them up for the run. If you want to, say, allow the window to scroll, use `scrollok()`. If you want the cursor to be left after the last change, use `leaveok()`. If this isn't done, `refresh()` moves the cursor to the window's current (y, x) coordinates after updating it. New windows of your own can be created, too, by using the functions `newwin()` and `subwin()`. `delwin()` gets rid of old windows. If you wish to change the official size of the terminal by hand, just set the variables *LINES* and *COLS* to be what you want, and then call `initscr()`. This is best done before, but can be done either before or after, the first call to `initscr()`, as it always deletes any existing ***stdscr*** and/or ***curscr*** before creating new ones.

3.2. The Nitty-Gritty

3.2.1. Output

Now that we have set things up, we will want to actually update the terminal. The basic functions used to change what appears on a window are `addch()` and `move()`. `addch()` adds a character at the current (y, x) coordinates, returning ERR if it would cause the window to illegally scroll, that is, printing a character in the lower right-hand corner of a terminal which

automatically scrolls if scrolling is not allowed. **move()** changes the current (y, x) coordinates to whatever you want them to be. It returns ERR if you try to move off the window when scrolling is not allowed. As mentioned above, you can combine the two into **mvaddch()** to do both things in one fell swoop.

The other output functions, such as **addstr()** and **printw()**, all call **addch()** to add characters to the window.

After you have put on the window what you want there, when you want the portion of the terminal covered by the window to be made to look like it, you must call **refresh()**. To optimize finding changes, **refresh()** assumes that any part of the window not changed since the last **refresh()** of that window has not been changed on the terminal, that is, that you have not refreshed a portion of the terminal with an overlapping window. If this is not the case, the routine **touchwin()** is provided to make it look like the entire window has been changed, thus making **refresh()** check the whole subsection of the terminal for changes.

If you call **wrefresh()** with *curscr*, it will make the screen look like *curscr* thinks it looks like. This is useful for implementing a command to redraw the screen in case it get messed up.

3.2.2. Input

Input is essentially a mirror image of output. The complementary function to **addch()** is **getch()** which, if echo is set, calls **addch()** to echo the character. Since the screen package needs to know what is on the terminal at all times, if characters are to be echoed, the tty must be in *raw* or *cbreak* mode. If it is not, **getch()** sets it to be *cbreak*, reads in the character, and then resets the mode of the terminal to what it was before the call.

3.2.3. Miscellaneous

All sorts of functions exist for maintaining and changing information about the windows. For the most part, the descriptions in section 5.4. should suffice.

3.3. Finishing up

To do certain optimizations, and, on some terminals, to work at all, some things must be done before the screen routines start up. These functions are performed in **getttmode()** and **setterm()**, which are called by **initscr()**. To clean up after the routines, the routine **endwin()** is provided. It restores tty modes to what they were when **initscr()** was first called. Thus, anytime after the call to initscr, **endwin()** should be called before exiting.

Chapter 4

Cursor Motion Optimization: Standing Alone

It is possible to use the cursor optimization functions of this screen package without the overhead and additional size of the screen updating functions. The screen updating functions are designed for uses where parts of the screen are changed, but the overall image remains the same. Certain other programs will find it difficult to use these functions in this manner without considerable unnecessary program overhead. For such applications, such as some '***crt hacks***'[3] and optimizing *cat*(1)-type programs, all that is needed is the motion optimizations. This, therefore, is a description of what goes on at the lower levels of this screen package. The descriptions assume a certain amount of familiarity with programming problems and some finer points of C. None of it is terribly difficult, but you should be forewarned.

4.1. Terminal Information

To use a terminal's features to the best of a program's abilities, you must first know what they are. The *termcap* database describes these, but a certain amount of decoding is necessary, and there are, of course, both efficient and inefficient ways of reading them in. The algorithm that CURSES uses is taken from **vi** and is efficient. It reads them into a set of variables whose names are two uppercase letters with some mnemonic value. For example, *HO* is a string which moves the cursor to the "home" position[4]. As there are two types of variables involving ttys, there are two routines. The first, `gettmode()`, sets some variables based upon the tty modes accessed by *gtty*(2) and *stty*(2). The second, `setterm()`, does a larger task by reading in the descriptions from the *termcap* database. This is the way these routines are used by `initscr()`:

```
if (isatty(0)) {
        gettmode();
        if (sp=getenv("TERM"))
                setterm(sp);
}
else
        setterm(Def_term);
_puts(TI);
_puts(VS);
```

[3] Graphics programs designed to run on character-oriented terminals.

[4] These names are identical to those variables used in the */etc/termcap* database to describe each capability. See Appendix A for a complete list of those read, and *termcap*(5) for a full description.

`isatty()` checks to see if file descriptor 0 is a terminal[5]. If it is, `gettmode()` sets the terminal description modes from a *gtty*(2). `getenv()` is then called to get the name of the terminal, and that value (if there is one) is passed to `setterm()`, which reads in the variables from *termcap* associated with that terminal. `getenv()` returns a pointer to a string containing the name of the terminal, which we save in the character pointer *sp*. If `isatty()` returns false, the default terminal *Def_term* is used. The *TI* and *VS* sequences initialize the terminal. `_puts()` is a macro which uses `tputs()` (see *termcap*(3X)) to put out a string. It is these things which `endwin()` undoes.

4.2. Movement Optimizations, or, Getting Over Yonder

Now that we have all this useful information, it would be nice to do something with it. The most difficult thing to do properly is motion optimization. When you consider how many different features various terminals have (tabs, backtabs, non-destructive space, home sequences, absolute tabs, ...) you can see that deciding how to get from here to there can be a decidedly non-trivial task.

After using `gettmode()` and `setterm()` to get the terminal descriptions, the function `mvcur()` deals with this task. Its usage is simple: you simply tell it where you are now and where you want to go. For example

```
mvcur(0, 0, LINES/2, COLS/2)
```

would move the cursor from the home position (0, 0) to the middle of the screen. If you wish to force absolute addressing, you can use the function `tgoto()` from the *termcap*(3X) routines, or you can tell `mvcur()` that you are impossibly far away. For example, to absolutely address the lower left hand corner of the screen from anywhere just claim that you are in the upper right hand corner:

```
mvcur(0, COLS-1, LINES-1, 0)
```

[5] `isatty()` is defined in the default C library function routines. It does a *gtty*(2) on the file descriptor and checks the return value.

Chapter 5

Curses Functions

In the following definitions, '†' means that the 'function' is really a **#define** macro with arguments. This means that it will not show up in stack traces in the debugger, or, in the case of such functions as **addch()**, it will show up as its '**w**' counterpart. The arguments are given to show the order and type of each. Their names are not mandatory, just suggestive.

5.1. Output Functions

5.1.1. addch *and* waddch — *Add Character to Window*

```
addch(ch) †
char    ch;

waddch(win, ch)
WINDOW  *win;
char    ch;
```

Add the character ***ch*** on the window at the current (y, x) co-ordinates. If the character is a newline ('\n') the line is cleared to the end, and the current (y, x) co-ordinates are changed to the beginning of the next line if newline mapping is on, or to the next line at the same x co-ordinate if it is off. A return ('\r') moves to the beginning of the line on the window. Tabs ('\t') are expanded into spaces in the normal tabstop positions of every eight characters. This returns ERR if it would cause the screen to scroll illegally.

5.1.2. addstr *and* waddstr — *Add String to Window*

```
addstr(st) †
char    *str;

waddstr(win, str)
WINDOW  *win;
char    *str;
```

Add the string pointed to by ***str*** on the window at the current (y, x) co-ordinates. This returns ERR if it would cause the screen to scroll illegally. In this case, it puts on as much as it can.

5.1.3. box — *Draw Box Around Window*

```
box(win, vert, hor)
WINDOW  *win;
char    vert, hor;
```

Draws a box around the window using ***vert*** as the character for drawing the vertical sides, and ***hor*** for drawing the horizontal lines. If scrolling is not allowed, and the window encompasses the lower right-hand corner of the terminal, the corners are left blank to avoid a scroll.

5.1.4. clear *and* wclear — *Reset Window*

```
clear() †

wclear(win)
WINDOW  *win;
```

Resets the entire window to blanks. If ***win*** is a screen, this sets the clear flag, which sends a clear-screen sequence on the next `refresh()` call. This also moves the current (y, x) co-ordinates to (0, 0).

5.1.5. clearok — *Set Clear Flag*

```
clearok(scr, boolf) †
WINDOW  *scr;
bool    boolf;
```

Sets the clear flag for the screen ***scr***. If ***boolf*** is TRUE, this forces a clear-screen to be printed on the next `refresh()`, or stop it from doing so if ***boolf*** is FALSE. This only works on screens, and, unlike `clear()`, does not alter the contents of the screen. If ***scr*** is ***curscr***, the next `refresh()` call causes a clear-screen, even if the window passed to `refresh()` is not a screen.

5.1.6. clrtobot *and* wclrtobot — *Clear to Bottom*

```
clrtobot() †

wclrtobot(win)
WINDOW  *win;
```

Wipes the window clear from the current (y, x) co-ordinates to the bottom. This does not force a clear-screen sequence on the next refresh under any circumstances. This has no associated '**mv**' command.

5.1.7. `clrtoeol` *and* `wclrtoeol` — *Clear to End of Line*

```
clrtoeol() †

wclrtoeol(win)
WINDOW  *win;
```

Wipes the window clear from the current (y, x) co-ordinates to the end of the line. This has no associated 'mv' command.

5.1.8. `delch` *and* `wdelch` — *Delete Character*

```
delch()

wdelch(win)
WINDOW  *win;
```

Delete the character at the current (y, x) co-ordinates. Each character after it on the line shifts to the left, and the last character becomes blank.

5.1.9. `deleteln` *and* `wdeleteln` — *Delete Current Line*

```
deleteln()

wdeleteln(win)
WINDOW  *win;
```

Delete the current line. Every line below the current one moves up, and the bottom line becomes blank. The current (y, x) co-ordinates remains unchanged.

5.1.10. `erase` *and* `werase` — *Erase Window*

```
erase() †

werase(win)
WINDOW  *win;
```

Erases the window to blanks without setting the clear flag. This is analagous to `clear()`, except that it never causes a clear-screen sequence to be generated on a `refresh()`. This has no associated '**mv**' command.

5.1.11. `insch` *and* `winsch` — *Insert Character*

```
insch(c)
char    c;

winsch(win, c)
WINDOW  *win;
char    c;
```

Insert *c* at the current (y, x) co-ordinates Each character after it shifts to the right, and the last character disappears. This returns ERR if it would cause the screen to scroll illegally.

5.1.12. `insertln` *and* `winsertln` — *Insert Line*

```
insertln()

winsertln(win)
WINDOW  *win;
```

Insert a line above the current one. Every line below the current line is shifted down, and the bottom line disappears. The current line becomes blank, and the current (y, x) co-ordinates remains unchanged. This returns ERR if it would cause the screen to scroll illegally.

5.1.13. `move` *and* `wmove` — *Move*

```
move(y, x) †
int     y, x;

wmove(win, y, x)
WINDOW  *win;
int     y, x;
```

Change the current (y, x) co-ordinates of the window to (***y, x***). This returns ERR if it would cause the screen to scroll illegally.

5.1.14. `overlay` — *Overlay Windows*

```
overlay(win1, win2)
WINDOW  *win1, *win2;
```

Overlay ***win1*** on ***win2***. The contents of ***win1***, insofar as they fit, are placed on ***win2*** at their starting (y, x) co-ordinates. This is done non-destructively, that is, blanks on ***win1*** leave the contents of the space on ***win2*** untouched.

5.1.15. `overwrite` — *Overwrite Windows*

```
overwrite(win1, win2)
WINDOW  *win1, *win2;
```

Overwrite *win1* on *win2*. The contents of *win1*, insofar as they fit, are placed on *win2* at their starting (y, x) co-ordinates. This is done destructively, that is, blanks on *win1* become blank on *win2*.

5.1.16. `printw` *and* `wprintw` — *Print to Window*

```
printw(fmt, arg1, arg2, ...)
char    *fmt;

wprintw(win, fmt, arg1, arg2, ...)
WINDOW  *win;
char    *fmt;
```

Performs a `printf()` on the window starting at the current (y, x) co-ordinates. It uses `addstr()` to add the string on the window. It is often advisable to use the field width options of `printf()` to avoid leaving things on the window from earlier calls. This returns ERR if it would cause the screen to scroll illegally.

5.1.17. `refresh` *and* `wrefresh` — *Synchronize*

```
refresh() †

wrefresh(win)
WINDOW  *win;
```

Synchronize the terminal screen with the desired window. If the window is not a screen, only that part covered by it is updated. This returns ERR if it would cause the screen to scroll illegally. In this case, it updates whatever it can without causing the scroll.

5.1.18. `standout` *and* `wstandout` — *Put Characters in Standout Mode*

```
standout() †

wstandout(win)
WINDOW  *win;

standend() †

wstandend(win)
WINDOW  *win;
```

Start and stop putting characters onto *win* in standout mode. `standout()` causes any characters added to the window to be put in standout mode on the terminal (if it has that capability). `standend()` stops this. The sequences *SO* and *SE* (or *US* and *UE* if they are not defined) are used (see Appendix A).

5.2. Input Functions

5.2.1. crmode *and* nocrmode — *Set or Unset from cbreak mode*

```
crmode() †
nocrmode() †
```

Set or unset the terminal to/from cbreak mode.

5.2.2. echo *and* noecho — *Turn Echo On or Off*

```
echo() †
noecho() †
```

Sets the terminal to echo or not echo characters.

5.2.3. getch *and* wgetch — *Get Character from Terminal*

```
getch() †
wgetch(win)
WINDOW  *win;
```

Gets a character from the terminal and (if necessary) echos it on the window. This returns ERR if it would cause the screen to scroll illegally. Otherwise, the character gotten is returned. If ***noecho*** has been set, then the window is left unaltered. In order to retain control of the terminal, it is necessary to have one of ***noecho, cbreak,*** or ***rawmode*** set. If you do not set one, whatever routine you call to read characters sets ***cbreak*** for you, and then resets to the original mode when finished.

5.2.4. getstr *and* wgetstr — *Get String from Terminal*

```
getstr(st) †
char    *str;
wgetstr(win, str)
WINDOW  *win;
char    *str;
```

Get a string through the window and put it in the location pointed to by ***str***, which is assumed to be large enough to handle it. It sets tty modes if necessary, and then calls **getch()** (or **wgetch(win)**) to get the characters needed to fill in the string until a newline or EOF is encountered. The newline stripped off the string. This returns ERR if it would cause the screen to scroll illegally.

5.2.5. raw *and* noraw — *Turn Raw Mode On or Off*

```
raw() †
noraw() †
```

Set or unset the terminal to/from raw mode. On version 7 UNIX† systems, this also turns off newline mapping (see nl()).

5.2.6. scanw *and* wscanw — *Read String from Terminal*

```
scanw(fmt, arg1, arg2, ...)
char    *fmt;

wscanw(win, fmt, arg1, arg2, ...)
WINDOW  *win;
char    *fmt;
```

Perform a scanf() through the window using *fmt*. It does this using consecutive getch()'s (or wgetch(win)'s). This returns ERR if it would cause the screen to scroll illegally.

5.3. Miscellaneous Functions

5.3.1. delwin — *Delete a Window*

```
delwin(win)
WINDOW  *win;
```

Deletes the window from existence. All resources are freed for future use by calloc(3). If a window has a subwin() allocated window inside of it, deleting the outer window does not affect the subwindow, even though this does invalidate it. Therefore, subwindows should be deleted before their outer windows are.

5.3.2. endwin — *Finish up Window Routines*

```
endwin()
```

Finish up window routines before exit. This restores the terminal to the state it was in before initscr() (or gettmode() and setterm()) was called. endwin should always be called before exiting. endwin does not itself exit — this is especially useful for resetting tty stats when trapping rubouts via signal(2).

---

[5] † UNIX is a trademark of Bell Laboratories.

5.3.3. getyx — *Get Current Coordinates*

```
getyx(win, y, x) †
WINDOW  *win;
int     y, x;
```

Puts the current (y, x) co-ordinates of ***win*** in the variables ***y*** and ***x***. Since it is a macro, not a function, you do not pass the address of ***y*** and ***x***.

5.3.4. inch *and* winch — *Get Character at Current Coordinates*

```
inch() †

winch(win) †
WINDOW  *win;
```

Returns the character at the current (y, x) co-ordinates on the given window. This does not make any changes to the window. This has no associated '**mv**' command.

5.3.5. initscr — *Initialize Screen Routines*

```
initscr()
```

Initialize the screen routines. This must be called before any of the screen routines are used. It initializes the terminal-type data and such, and without it, none of the routines can operate. If standard input is not a tty, it sets the specifications to the terminal whose name is pointed to by *Def_term* (initialy "dumb"). If the boolean *My_term* is true, *Def_term* is always used.

5.3.6. leaveok — *Set Leave Cursor Flag*

```
leaveok(win, boolf) †
WINDOW  *win;
bool    boolf;
```

Sets the boolean flag for leaving the cursor after the last change. If ***boolf*** is TRUE, the cursor is left after the last update on the terminal, and the current (y, x) co-ordinates for ***win*** are changed accordingly. If it is FALSE, it is moved to the current (y, x) co-ordinates. This flag (initially FALSE) retains its value until changed by the user.

For example, say the current position is (0, 0) and we change the character at position (5, 10) in the window. After calling **refresh()**, the cursor is either moved to position (5, 10) (if the flag is TRUE) or the cursor is left at position (0, 0) (if the flag is FALSE).

5.3.7. longname — *Get Full Name of Terminal*

```
longname(termbuf, name)
char    *termbuf, *name;
```

Fills in ***name*** with the long (full) name of the terminal described by the termcap entry in ***termbuf***. It is generally of little use, but is nice for telling the user in a readable format what terminal we think he has. The long name is also available in the global variable ***ttytype***. ***Termbuf*** is usually set via the termlib routine `tgetent()`.

5.3.8. mvwin — *Move Home Position of Window*

```
mvwin(win, y, x)
WINDOW  *win;
int     y, x;
```

Move the home position of the window ***win*** from its current starting coordinates to (***y, x***). If that would put part or all of the window off the edge of the terminal screen, `mvwin()` returns ERR and does not change anything.

5.3.9. newwin — *Create a New Window*

```
WINDOW *
newwin(lines, cols, begin_y, begin_x)
int     lines, cols, begin_y, begin_x;
```

Create a new window with ***lines*** lines and ***cols*** columns starting at position (***begin_y, begin_x***). If either ***lines*** or ***cols*** is 0 (zero), that dimension is set to (*LINES* − ***begin_y***) or (*COLS* − ***begin_x***) respectively. Thus, to get a new window of dimensions *LINES* × *COLS*, use `newwin(0, 0, 0, 0)`.

5.3.10. nl *and* nonl — *Turn Newline Mode On or Off*

```
nl() †
nonl() †
```

Set or unset the terminal to/from nl mode, that is, start/stop the system from mapping ***<carriage-return>*** to ***<line-feed>***. If the mapping is not done, `refresh()` can do more optimization, so it is recommended, but not required, that it be turned off.

5.3.11. scrollok — *Set Scroll Flag for Window*

```
scrollok(win, boolf) †
WINDOW  *win;
bool    boolf;
```

Set the scroll flag for the given window. If ***boolf*** is FALSE, scrolling is not allowed. This is its default setting.

5.3.12. touchwin — *Indicate Window Has Been Changed*

```
touchwin(win)
WINDOW  *win;
```

Make it appear that the every location on the window has been changed. This is usually only needed for refreshes with overlapping windows.

5.3.13. subwin — *Create a Subwindow*

```
WINDOW *
subwin(win, lines, cols, begin_y, begin_x)
WINDOW  *win;
int     lines, cols, begin_y, begin_x;
```

Create a new window with ***lines*** lines and ***cols*** columns starting at position (***begin_y, begin_x***) in the middle of the window ***win***. This means that any change made to either window in the area covered by the subwindow is made on both windows. ***begin_y, begin_x*** are specified relative to the overall screen, not the relative (0, 0) of ***win***. If either ***lines*** or ***cols*** is 0 (zero), that dimension is set to (*LINES* − ***begin_y***) or (*COLS* − ***begin_x***) respectively.

5.3.14. unctrl — *Return Representation of Character*

```
unctrl(ch) †
char    ch;
```

This is actually a debug function for the library, but it is of general usefulness. It returns a string which is a representation of ***ch***. Control characters become their upper-case equivalents preceded by a "^". Other letters stay just as they are.

5.4. Details

5.4.1. gettmode — *Get tty Statistics*

```
gettmode()
```

Get the tty stats. This is normally called by **initscr()**.

5.4.2. mvcur — *Move Cursor*

```
mvcur(lasty, lastx, newy, newx)
int     lasty, lastx, newy, newx;
```

Moves the terminal's cursor from (***lasty, lastx***) to (***newy, newx***) in an approximation of optimal fashion. It is possible to use this optimization without the benefit of the screen routines. With the screen routines, this should not be called by the user. **move()** and **refresh()** should be used to move the cursor position, so that the routines know what's going on.

5.4.3. scroll — *Scroll Window*

```
scroll(win)
WINDOW  *win;
```

Scroll the window upward one line. This is normally not used by the user.

5.4.4. savetty *and* resetty — *Save and Reset tty Flags*

```
savetty() †
resetty() †
```

savetty() saves the current tty characteristic flags. **resetty()** restores them to what **savetty()** stored. These functions are performed automatically by **initscr()** and **endwin()**.

5.4.5. setterm — *Set Terminal Characteristics*

```
setterm(name)
char    *name;
```

Set the terminal characteristics to be those of the terminal named ***name***. This is normally called by **initscr()**.

5.4.6. `tstp`

`tstp()`

If the new *tty*(4) driver is in use, this function saves the current tty state and then puts the process to sleep. When the process gets restarted, it restores the tty state and then calls `wrefresh(curscr)` to redraw the screen. `initscr()` sets the signal SIGTSTP to trap to this routine.

Appendix A

Capabilities from termcap

A.1. Disclaimer

The description of terminals is a difficult business, and we only attempt to summarize the capabilities here. For a full description see the **termcap**(5) manual pages.

A.2. Overview

Capabilities from termcap are of three kinds: string valued options, numeric valued options, and boolean options. The string valued options are the most complicated, since they may include padding information.

Intelligent terminals often require padding on intelligent operations at high (and sometimes even low) speed. This is specified by a number before the string in the capability, and has meaning for the capabilities which have a **P** at the front of their comment. This normally is a number of milliseconds to pad the operation. In the current system which has no true programmable delays, we do this by sending a sequence of pad characters (normally nulls, but can be changed — specified by *PC*). In some cases, the pad is better computed as some number of milliseconds times the number of affected lines (to the bottom of the screen usually, except when terminals have insert modes which will shift several lines.) This is specified as, for example, **12*** before the capability, to say 12 milliseconds per affected whatever (currently always line). Capabilities where this makes sense say **P***.

A.3. Variables Set By setterm()

Table A-1: Variables Set by setterm()

variables set by setterm()			
Type	*Name*	*Pad*	*Description*
char *	AL	P*	Add new blank Line
bool	AM		Automatic Margins
char *	BC		Back Cursor movement
bool	BS		BackSpace works
char *	BT	P	Back Tab
bool	CA		Cursor Addressable
char *	CD	P*	Clear to end of Display
char *	CE	P	Clear to End of line
char *	CL	P*	CLear screen
char *	CM	P	Cursor Motion
char *	DC	P*	Delete Character
char *	DL	P*	Delete Line sequence
char *	DM		Delete Mode (enter)
char *	DO		DOwn line sequence
char *	ED		End Delete mode
bool	EO		can Erase Overstrikes with ' '
char *	EI		End Insert mode
char *	HO		HOme cursor
bool	HZ		HaZeltine ~ braindamage
char *	IC	P	Insert Character
bool	IN		Insert-Null blessing
char *	IM		enter Insert Mode (IC usually set, too)
char *	IP	P*	Pad after char Inserted using IM+IE
char *	LL		quick to Last Line, column 0
char *	MA		ctrl character MAp for cmd mode
bool	MI		can Move in Insert mode
bool	NC		No Cr: \r sends \r\n then eats \n
char *	ND		Non-Destructive space
bool	OS		OverStrike works
char	PC		Pad Character
char *	SE		Standout End (may leave space)
char *	SF	P	Scroll Forwards
char *	SO		Stand Out begin (may leave space)
char *	SR	P	Scroll in Reverse
char *	TA	P	TAb (not ^I or with padding)
char *	TE		Terminal address enable Ending sequence
char *	TI		Terminal address enable Initialization
char *	UC		Underline a single Character

variables set by setterm()			
Type	*Name*	*Pad*	*Description*
char *	UE		Underline Ending sequence
bool	UL		UnderLining works even though !OS
char *	UP		UPline
char *	US		Underline Starting sequence[7]
char *	VB		Visible Bell
char *	VE		Visual End sequence
char *	VS		Visual Start sequence
bool	XN		a Newline gets eaten after wrap

Names starting with *X* are reserved for severely nauseous glitches

A.4. Variables Set By gettmode()

Table A-2: Variables Set By gettmode()

variables set by gettmode()		
type	*name*	*description*
bool	NONL	Term can't hack linefeeds doing a CR
bool	GT	Gtty indicates Tabs
bool	UPPERCASE	Terminal generates only uppercase letters

[7] US and UE, if they do not exist in the termcap entry, are copied from SO and SE in *setterm*()

Appendix B

The WINDOW structure

The WINDOW structure is defined as follows:

```
# define        WINDOW  struct _win_st

struct _win_st {
        short   _cury, _curx;
        short   _maxy, _maxx;
        short   _begy, _begx;
        short   _flags;
        bool    _clear;
        bool    _leave;
        bool    _scroll;
        char    **_y;
        short   *_firstch;
        short   *_lastch;
};

# define        _SUBWIN         01
# define        _ENDLINE        02
# define        _FULLWIN        04
# define        _SCROLLWIN      010
# define        _STANDOUT       0200
```

_cury and *_curx* are the current (y, x) coordinates for the window. New characters added to the screen are added at this point. *_maxy* and *_maxx* are the maximum values allowed for (*_cury*, *_curx*). *_begy* and *_begx* are the starting (y, x) coordinates on the terminal for the window, that is, the window's home. *_cury*, *_curx*, *_maxy*, and *_maxx* are measured relative to (*_begy*, *_begx*), not the terminal's home.

_clear tells if a clear-screen sequence is to be generated on the next `refresh()` call. This is only meaningful for screens. The initial clear-screen for the first `refresh()` call is generated by initially setting clear to be TRUE for *curscr*, which always generates a clear-screen if set, irrelevant of the dimensions of the window involved. *_leave* is TRUE if the current (y, x) coordinates and the cursor are to be left after the last character changed on the terminal, or not moved if there is no change. *_scroll* is TRUE if scrolling is allowed.

[7] All variables not normally accessed directly by the user are named with an initial '_' to avoid conflicts with the user's variables.

_y is a pointer to an array of lines which describe the terminal. Thus:

```
_y[i]
```

is a pointer to the *i*th line, and

```
_y[i][j]
```

is the *j*th character on the *i*th line.

_flags can have one or more values or'd into it. _SUBWIN means that the window is a subwindow, which indicates to **delwin()** that the space for the lines is not to be freed. _ENDLINE says that the end of the line for this window is also the end of a screen. _FULLWIN says that this window is a screen. _SCROLLWIN indicates that the last character of this screen is at the lower right-hand corner of the terminal; that is, if a character was put there, the terminal would scroll. _STANDOUT says that all characters added to the screen are in standout mode.

Appendix C

Examples

Here we present a few examples of how to use the package. They attempt to be representative, though not comprehensive.

C.1. Screen Updating

The following examples are intended to demonstrate the basic structure of a program using the screen updating sections of the package. Several of the programs require calculational sections which are irrelevant to the example, and are therefore usually not included. It is hoped that the data structure definitions give enough of an idea to allow understanding of what the relevant portions do. The rest is left as an exercise to the reader.

C.1.1. Twinkle

This is a moderately simple program which prints pretty patterns on the screen that might even hold your interest for 30 seconds or more. It switches between patterns of asterisks, putting them on one by one in random order, and then taking them off in the same fashion. It is more efficient to write this using only the motion optimization, as is demonstrated below.

```
# include       <curses.h>
# include       <signal.h>

/*
 * the idea for this program was a product of the imagination of
 * Kurt Schoens.  Not responsible for minds lost or stolen.
 */

# define        NCOLS   80
# define        NLINES  24
# define        MAXPATTERNS     4

struct locs {
        char    y, x;
};

typedef struct locs     LOCS;

LOCS    Layout[NCOLS * NLINES]; /* current board layout */

int     Pattern,                /* current pattern number */
        Numstars;               /* number of stars in pattern */

main() {

        char            *getenv();
        int             die();

        srand(getpid());                /* initialize random sequence */

        initscr();
        signal(SIGINT, die);
        noecho();
        nonl();
        leaveok(stdscr, TRUE);
        scrollok(stdscr, FALSE);

        for (;;) {
                makeboard();            /* make the board setup */
                puton('*');             /* put on '*'s */
                puton(' ');             /* cover up with ' 's */
        }
}

/*
 * On program exit, move the cursor to the lower left corner by
 * direct addressing, since current location is not guaranteed.
 * We lie and say we used to be at the upper right corner to guarantee
 * absolute addressing.
 */
die() {

        signal(SIGINT, SIG_IGN);
        mvcur(0, COLS-1, LINES-1, 0);
```

```
        endwin();
        exit(0);
}


/*
 * Make the current board setup.  It picks a random pattern and
 * calls ison() to determine if the character is on that pattern
 * or not.
 */
makeboard() {

        reg int         y, x;
        reg LOCS        *lp;

        Pattern = rand() % MAXPATTERNS;
        lp = Layout;
        for (y = 0; y < NLINES; y++)
                for (x = 0; x < NCOLS; x++)
                        if (ison(y, x)) {
                                lp->y = y;
                                lp++->x = x;
                        }
        Numstars = lp - Layout;
}

/*
 * Return TRUE if (y, x) is on the current pattern.
 */
ison(y, x)
reg int y, x; {

        switch (Pattern) {
          case 0:       /* alternating lines */
                return !(y & 01);
          case 1:       /* box */
                if (x >= LINES && y >= NCOLS)
                        return FALSE;
                if (y < 3 || y >= NLINES - 3)
                        return TRUE;
                return (x < 3 || x >= NCOLS - 3);
          case 2:       /* holy pattern! */
                return ((x + y) & 01);
          case 3:       /* bar across center */
                return (y >= 9 && y <= 15);
        }
        /* NOTREACHED */
}

puton(ch)
reg char        ch; {

        reg LOCS        *lp;
        reg int         r;
```

```
        reg LOCS        *end;
        LOCS            temp;

        end = &Layout[Numstars];
        for (lp = Layout; lp < end; lp++) {
                r = rand() % Numstars;
                temp = *lp;
                *lp = Layout[r];
                Layout[r] = temp;
        }

        for (lp = Layout; lp < end; lp++) {
                mvaddch(lp->y, lp->x, ch);
                refresh();
        }
}
```

C.1.2. Life

This program plays the famous computer pattern game of life (Scientific American, May, 1974). The calculational routines create a linked list of structures defining where each piece is. Nothing here claims to be optimal, merely demonstrative. This program, however, is a very good place to use the screen updating routines, as it allows them to worry about what the last position looked like, so you don't have to. It also demonstrates some of the input routines.

```
# include       <curses.h>
# include       <signal.h>

/*
 *      Run a life game.  This is a demonstration program for
 * the Screen Updating section of the -lcurses cursor package.
 */

struct lst_st {                 /* linked list element */
        int             y, x;           /* (y, x) position of piece */
        struct lst_st   *next, *last;   /* doubly linked */
};

typedef struct lst_st   LIST;

LIST    *Head;                  /* head of linked list */

main(ac, av)
int     ac;
char    *av[]; {

        int     die();

        evalargs(ac, av);               /* evaluate arguments */

        initscr();                      /* initialize screen package */
        signal(SIGINT, die);            /* set to restore tty stats */
        crmode();                       /* set for char-by-char */
        noecho();                       /*      input */
        nonl();                         /* for optimization */

        getstart();                     /* get starting position */
        for (;;) {
                prboard();              /* print out current board */
                update();               /* update board position */
        }
}

/*
 * This is the routine which is called when rubout is hit.
 * It resets the tty stats to their original values.  This
 * is the normal way of leaving the program.
 */
die() {

        signal(SIGINT, SIG_IGN);        /* ignore rubouts */
        mvcur(0, COLS-1, LINES-1, 0);   /* go to bottom of screen */
        endwin();                       /* set terminal to initial state */
        exit(0);
}

/*
 * Get the starting position from the user.  They keys u, i, o, j, l,
 * m, ,, and . are used for moving their relative directions from the
```

```
 * k key.  Thus, u move diagonally up to the left, , moves directly down,
 * etc.  x places a piece at the current position, " " takes it away.
 * The input can also be from a file.  The list is built after the
 * board setup is ready.
 */
getstart() {

        reg char        c;
        reg int         x, y;
        char    *buf;

        box(stdscr, '|', '_');          /* box in the screen */
        move(1, 1);                     /* move to upper left corner */

        do {
                refresh();              /* print current position */
                if ((c=getch()) == 'q')
                        break;
                switch (c) {
                  case 'u':
                  case 'i':
                  case 'o':
                  case 'j':
                  case 'l':
                  case 'm':
                  case ',':
                  case '.':
                        adjustyx(c);
                        break;
                  case 'f':
                        mvaddstr(0, 0, "File name: ");
                        getstr(buf);
                        readfile(buf);
                        break;
                  case 'x':
                        addch('X');
                        break;
                  case ' ':
                        addch(' ');
                        break;
                }
        }

        if (Head != NULL)                       /* start new list */
                dellist(Head);
        Head = malloc(sizeof (LIST));

        /*
         * loop through the screen looking for 'x's, and add a list
         * element for each one
         */
        for (y = 1; y < LINES - 1; y++)
                for (x = 1; x < COLS - 1; x++) {
                        move(y, x);
```

```
                        if (inch() == 'x')
                                addlist(y, x);
                }
}

/*
 * Print out the current board position from the linked list
 */
prboard() {

        reg LIST        *hp;

        erase();                        /* clear out last position */
        box(stdscr, '|', '_');          /* box in the screen */

        /*
         * go through the list adding each piece to the newly
         * blank board
         */
        for (hp = Head; hp; hp = hp->next)
                mvaddch(hp->y, hp->x, 'X');

        refresh();
}
```

C.2. Motion optimization

The following example shows how motion optimization is written on its own. Programs which flit from one place to another without regard for what is already there usually do not need the overhead of both space and time associated with screen updating. They should instead use motion optimization.

C.2.1. Twinkle

The **twinkle** program is a good candidate for simple motion optimization. Here is how it could be written (only the routines that have been changed are shown):

```
main() {

        reg char        *sp;
        char            *getenv();
        int             _putchar(), die();

        srand(getpid());                /* initialize random sequence */

        if (isatty(0)) {
                gettmode();
                if (sp=getenv("TERM"))
                        setterm(sp);
                signal(SIGINT, die);
        }
        else {
                printf("Need a terminal on %d0, _tty_ch);
                exit(1);
        }
        _puts(TI);
        _puts(VS);

        noecho();
        nonl();
        tputs(CL, NLINES, _putchar);
        for (;;) {
                makeboard();            /* make the board setup */
                puton('*');             /* put on '*'s */
                puton(' ');             /* cover up with ' 's */
        }
}

/*
 * _putchar defined for tputs() (and _puts())
 */
_putchar(c)
reg char        c; {

        putchar(c);
}

puton(ch)
char    ch; {

        static int      lasty, lastx;
        reg LOCS        *lp;
        reg int         r;
        reg LOCS        *end;
        LOCS            temp;

        end = &Layout[Numstars];
        for (lp = Layout; lp < end; lp++) {
                r = rand() % Numstars;
                temp = *lp;
                *lp = Layout[r];
```

```
                Layout[r] = temp;
        }

        for (lp = Layout; lp < end; lp++)
                /* prevent scrolling */
                if (!AM || (lp->y < NLINES - 1 || lp->x < NCOLS - 1)) {
                        mvcur(lasty, lastx, lp->y, lp->x);
                        putchar(ch);
                        lasty = lp->y;
                        if ((lastx = lp->x + 1) >= NCOLS)
                                if (AM) {
                                        lastx = 0;
                                        lasty++;
                                }
                                else
                                        lastx = NCOLS - 1;
                }
}
```

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