Screen Updating and Cursor Movement Optimization: A Library Package

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ABSTRACT

This document describes a package of C library functions which allow the user to:

- update a screen with reasonable optimization,
- get input from the terminal in a screen-oriented fashion, and
- independent from the above, move the cursor optimally from one point to another.

These routines all use the **termcap**(5) database to describe the capabilities of the terminal.

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1. Overview

In making available the generalized terminal descriptions in **termcap**(5), much information was made available to the programmer, but little work was taken out of one's hands. The purpose of this package is to allow the C programmer to do the most common type of terminal dependent functions, those of movement optimization and optimal screen updating, without doing any of the dirty work, and with nearly as much ease as is necessary to simply print or read things.

1.1. Terminology

In this document, the following terminology is used:

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.

terminal: Sometimes called **terminal screen**. The package's idea of what the terminal's screen currently looks like, *i.e.*, 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, *i.e.*, 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. Compiling Applications

In order to use the 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. Compilations should have the following form:

cc [*flags*] file ... **–lcurses –ltermcap**

1.3. Screen Updating

In order 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) co-ordinates 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 the package will execute the changes in an optimal way.

1.4. Naming Conventions

As hinted above, the routines can use several windows, but two are always available: *curscr*, which is the image of what the terminal looks like at present, and *stdscr*, which is the image of what the programmer wants the terminal to look like next. The user should not 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 **w**indow-specific **addch**()) is provided[1]. 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.

In order to move the current (y, x) co-ordinates 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. In order to avoid clumsiness, most I/O routines can be preceded by the prefix ‘‘**mv**’’ and the desired (y, x) co-ordinates can then be added to the arguments to the function. For example, the calls

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

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) co-ordinates. If a window pointer is needed, it is always the first parameter passed.

2. Variables

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

type	name	description
WINDOW *	curscr	current version of the screen (terminal screen).
WINDOW *	stdscr	standard screen. Most updates are usually 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	flag returned by routines upon success.

3. Usage

This is a description of how to actually use the screen package. For simplicity, we assume all updating, reading, etc. is applied to *stdscr*, although a different window can of course be specified.

3.1. Initialization

In order 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

[1] Actually, **addch**() is really a ‘‘#define’’ macro with arguments, as are most of the "functions" which act upon *stdscr*.

checking for startup errors. Terminal status changing routines like **nl**() and **cbreak**() should be called after **initscr**().

After the initial window allocation done by **initscr**(), specific window characteristics can be set. Scrolling can be enabled by calling **scrollok**(). If you want the cursor to be left after the last change, use **leaveok**(). If this isn't done, **refresh**() will move the cursor to the window's current (y, x) co-ordinates after updating it. Additional windows can be created by using the functions **newwin**() and **subwin**(). **Delwin**() allows you to delete an exisiting window. The variables *LINES* and *COLS* control the size of the terminal. They are initially implicitly set by **initscr**(), but can be altered explicitly by the user followed by a call to **initscr**(). Note that any call to **initscr**(), will always delete any existing *stdscr* and/or *curscr* before creating new ones so this change is best done before the initial call to **initscr**().

3.2. Output

The basic functions used to change what will go on a window are **addch**() and **move**(). **Addch**() adds a character at the current (y, x) co-ordinates, returning ERR if it would cause the window to illegally scroll, *i.e.*, 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) co-ordinates to whatever you want them to be. It returns ERR if you try to move off the window. As mentioned above, you can combine the two into **mvaddch**() to do both things in one call.

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

After a change has been made to the window, you must call **refresh**(). when you want the portion of the terminal covered by the window to reflect the change. In order 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, *i.e.*, that you have not refreshed a portion of the terminal with an overlapping window. If this is not the case, the routines **touchwin**(), **touchline**(), and **touchoverlap**() are provided to make it look like a desired part of window has been changed, thus forcing **refresh**() to check that whole subsection of the terminal for changes.

If you call **wrefresh**() with *curscr*, it will make the screen look like the image of *curscr*. This is useful for implementing a command which would redraw the screen in case it got messed up.

3.3. Input

Input is essentially a mirror image of output. The complementary function to **addch**() is **getch**() which, if echo is set, will call **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, and then reads in the character.

3.4. Termination

In order to perform 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**(). In order to clean up after the routines, the routine **endwin**() is provided. It restores tty modes to what they were when **initscr**() was first called. The terminal state module uses the variable *curses_termios* to save the original terminal state which is then restored upon a call to **endwin**(). Thus, anytime after the call to initscr, **endwin**() should be called before exiting. Note however, that **endwin**() should always be called **before** the final calls to **delwin**(), which free the storage of the windows.

4. Cursor Movement Optimizations

One of the most difficult things to do properly is motion optimization. After using **gettmode**() and **setterm**() to get the terminal descriptions, the function **mvcur**() deals with this task. It usage is simple: 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 **termlib**(7) 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. Character Output and Scrolling

The character output policy deals with the following problems. First, where is the location of the cursor after a character is printed, and secondly, when does the screen scroll if scrolling is enabled.

In the normal case the characters are output as expected, with the cursor occupying the position of the next character to be output. However, when the cursor is on the last column of the line, the cursor will remain on that position after the last character on the line is output and will only assume the position on the next line when the next character (the first on the next line) is output.

Likewise, if scrolling is enabled, a scroll will be invoked only when the first character on he first line past the bottom line of the window is output. If scrolling is not enabled the chracters will to be output to the bottom right corner of the window which is the cursor location.

This policy allows consistent behavior of the cursor at the boundary conditions. Furthermore, it prevents a scroll from happening before it is actually needed (the old package used to scroll when the bottom right position was output a character). As a precendent, it models the *xterm* character output conventions.

6. Terminal State Handling

The variable *curses_termios* contains the terminal state of the terminal. Certain historical routines return information: **baudrate**(), **erasechar**(), **killchar**(), and **ospeed**(). These routines are obsolete and exist only for backward compatibility. If you wish to use the information in the *curses_termios* structure, you should use the *tsetattr*(3) routines.

7. Subwindows

Subwindows are windows which do not have an independent text structure, *i.e.*, they are windows whose text is a subset of the text of a larger window: the *parent* window. One consequence of this is that changes to either the parent or the child window are destructive to the other, *i.e.*, a change to the subwindow is also a change to the parent window and a change to the parent window in the region defined by the subwindow is implicitly a change to the subwindow as well. Apart from this detail, subwindows function like any other window.

8. The Functions

In the following definitions, ‘‘**†**’’ means that the ‘‘function’’ is really a ‘‘#define’’ macro with arguments.

addch(*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 will be cleared to the end, and the current (y, x) co-ordinates will be changed to the beginning off 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´) will move to the beginning of the line on the window. Tabs (´\t´) will be expanded into spaces in the normal tabstop positions of every eight characters. This returns ERR if it would cause the screen to scroll illegally.

addstr(*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 will put on as much as it can.

baudrate();†

Returns the output baud rate of the terminal. This is a system dependent constant (defined in **<sys/tty.h>** on BSD systems, which is included by **<curses.h>**).

box(*WINDOW win*, *char vert*, *char 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.

cbreak();†

Set or the terminal to cbreak mode.

clear();†

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

clearok(*WINDOW *scr*, *int boolf*);†

Sets the clear flag for the screen *scr*. If *boolf* is non-zero, this will force a clear-screen to be printed on the next **refresh**(), or stop it from doing so if *boolf* is 0. This only works on screens, and, unlike **clear**(), does not alter the contents of the screen. If *scr* is *curscr*, the next **refresh**() call will cause a clear-screen, even if the window passed to **refresh**() is not a screen.

clrtobot();†

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.

clrtoeol();†

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

crmode();†

Identical to **cbreak**(). The misnamed macro **crmode**() and **nocrmode**() is retained for backwards compatibility with ealier versions of the library.

delch();

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.

deleteln();

Delete the current line. Every line below the current one will move up, and the bottom line will become blank. The current (y, x) co-ordinates will remain unchanged.

delwin(*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 the subwindow is not affected, even though this does invalidate it. Therefore, subwindows should be deleted before their outer windows are.

echo();†

Sets the terminal to echo characters.

endwin();

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

erase();†

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.

erasechar();†

Returns the erase character for the terminal, *i.e.*, the character used by the user to erase a single character from the input.

flushok(*WINDOW ∗win, int boolf*);

Normally, **refresh**() **fflush**(*'s*); *stdout* when it is finished. **flushok**() allows you to control this. if *boolf* is non-zero (*i.e.*, non-zero) it will do the **fflush**(), otherwise it will not.

getch();†

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 will set *cbreak* for you, and then reset to the original mode when finished.

getstr(*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**()) 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.

gettmode();

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

getyx(*WINDOW ∗win, int y, int 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*.

idlok(*WINDOW ∗win, int boolf*);

Reserved for future use. This will eventually signal to **refresh**() that it is all right to use the insert and delete line sequences when updating the window.

`inch`();†

Returns the character at the current position on the given window. This does not make any changes to the window.

`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* (initially "dumb"). If the boolean *My_term* is non-zero, *Def_term* is always used. If the system supports the **TIOCGWINSZ** *ioctl(2)* call, it is used to get the number of lines and columns for the terminal, otherwise it is taken from the **termcap** description.

`insch`(*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.

`insertln`();

Insert a line above the current one. Every line below the current line will be shifted down, and the bottom line will disappear. The current line will become blank, and the current (y, x) co-ordinates will remain unchanged.

`killchar`();†

Returns the line kill character for the terminal, *i.e.*, the character used by the user to erase an entire line from the input.

`leaveok`(*WINDOW *win, int boolf*);†

Sets the boolean flag for leaving the cursor after the last change. If *boolf* is non-zero, the cursor will be left after the last update on the terminal, and the current (y, x) co-ordinates for *win* will be changed accordingly. If *boolf*
is 0 the cursor will be moved to the current (y, x) co-ordinates. This flag (initially 0) retains its value until changed by the user.

`move`(*int y, int 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.

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

Moves the terminal's cursor from (*lasty*, *lastx*) to (*newy*, *newx*) in an approximation of optimal fashion. This routine uses the functions borrowed from *ex* version 2.6. 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.

`mvprintw`(*int y, int x, const char *fmt, ...*);

Equivalent to:

```
move(y, x);
printw(fmt, ...);
```

mvscanw(*int y*, *int x*, *const char *fmt*, *...*);

Equivalent to:

```
move(y, x);
scanw(fmt, ...);
```

mvwin(*WINDOW *win*, *int y*, *int 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. For subwindows, **mvwin**() also returns ERR if you attempt to move it off its main window. If you move a main window, all subwindows are moved along with it.

mvwprintw(*WINDOW *win*, *int y*, *int x*, *const char *fmt*, *...*);

Equivalent to:

```
wmove(win, y, x);
printw(fmt, ...);
```

mvwscanw(*WINDOW *win*, *int y*, *int x*, *const char *fmt*, *...*);

Equivalent to:

```
wmove(win, y, x);
scanw(fmt, ...);
```

newwin(*int lines*, *int cols*, *int begin_y*, *int 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 will be 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*).

nl();†

Set the terminal to nl mode, *i.e.*, start/stop the system from mapping **<RETURN>** to **<LINE-FEED>**. If the mapping is not done, **refresh**() can do more optimization, so it is recommended, but not required, to turn it off.

nocbreak();†

Unset the terminal from cbreak mode.

nocrmode();†

Identical to **nocbreak**(). The misnamed macro **nocrmode**() is retained for backwards compatibility with ealier versions of the library.

noecho();†

Turn echoing of characters off.

nonl();†

Unset the terminal to from nl mode. See **nl**().

noraw();†

Unset the terminal from raw mode. See **raw**().

overlay(*WINDOW ∗win1*, *WINDOW ∗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, i.e., blanks on *win1* leave the contents of the space on *win2* untouched. Note that all non-blank characters are overwritten destructively in the overlay.

overwrite(*WINDOW ∗win1*, *WINDOW ∗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, *i.e.*, blanks on *win1* become blank on *win2*.

printw(*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.

raw();†

Set the terminal to raw mode. On version 7 UNIX[2] this also turns off newline mapping (see **nl**()).

refresh();†

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 will update whatever it can without causing the scroll.

As a special case, if **wrefresh**() is called with the window *curscr* the screen is cleared and repainted as it is currently. This is very useful for allowing the redrawing of the screen when the user has garbage dumped on his terminal.

resetty();†

resetty() restores them to what **savetty**() stored. These functions are performed automatically by **initscr**() and **endwin**(). This function should not be used by the user.

savetty();†

savetty() saves the current tty characteristic flags. See **resetty**(). This function should not be used by the user.

scanw(*char ∗fmt*, ...);

Perform a **scanf**() through the window using *fmt*. It does this using consecutive calls to **getch**()

[2] UNIX is a trademark of Unix System Laboratories.

(or **wgetch**()). This returns ERR if it would cause the screen to scroll illegally.

scroll(*WINDOW ∗win*);

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

scrollok(*WINDOW ∗win*, *int boolf*);†

Set the scroll flag for the given window. If *boolf* is 0, scrolling is not allowed. This is its default setting.

standend();†

End standout mode initiated by **standout**().

standout();†

Causes any characters added to the window to be put in standout mode on the terminal (if it has that capability).

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

Create a new window with *lines* lines and *cols* columns starting at position (*begin_y*, *begin_x*) inside the window *win*. This means that any change made to either window in the area covered by the subwindow will be 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 will be set to (*LINES* − *begin_y*) or (*COLS* − *begin_x*) respectively.

touchline(*WINDOW ∗win*, *int y*, *int startx*, *int endx*);

This function performs a function similar to **touchwin**() on a single line. It marks the first change for the given line to be *startx*, if it is before the current first change mark, and the last change mark is set to be *endx* if it is currently less than *endx*.

touchoverlap(*WINDOW ∗win1*, *WINDOW ∗win2*);

Touch the window *win2* in the area which overlaps with *win1*. If they do not overlap, no changes are made.

touchwin(*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.

tstp()

This function will save the current tty state and then put the process to sleep. When the process gets restarted, it restores the saved tty state and then calls **wrefresh**(*curscr*); to redraw the screen. **Initscr**() sets the signal SIGTSTP to trap to this routine.

unctrl(*char ∗ch*);†

Returns a string which is an ASCII representation of *ch*. Characters are 8 bits long.

unctrllen(*char ∗ch*);†

Returns the length of the ASCII representation of *ch*.

`vwprintw`(*WINDOW ∗win*, *const char ∗fmt*, *va_list ap*);

Identical to **`printw`**() except that it takes both a window specification and a pointer to a variable length argument list.

`vwscanw`(*WINDOW ∗win*, *const char ∗fmt*, *va_list ap*);

Identical to **`scanw`**() except that it takes both a window specification and a pointer to a variable length argument list.

`waddbytes`(*WINDOW ∗win*, *char ∗str*, *int len*);

This function is the low level character output function. *Len* characters of the string *str* are output to the current (y, x) co-ordinates position of the window specified by *win.*

The following functions differ from the standard functions only in their specification of a window, rather than the use of the default stdscr.

`waddch`(*WINDOW ∗win*, *char ch*);
`waddstr`(*WINDOW ∗win*, *char ∗str*);
`wclear`(*WINDOW ∗win*);
`wclrtobot`(*WINDOW ∗win*);
`wclrtoeol`(*WINDOW ∗win*);
`wdelch`(*WINDOW ∗win*);
`wdeleteln`(*WINDOW ∗win*);
`werase`(*WINDOW ∗win*);
`wgetch`(*WINDOW ∗win*);
`wgetstr`(*WINDOW ∗win*, *char ∗str*);
`winch`(*WINDOW ∗win*);†
`winsch`(*WINDOW ∗win*, *char c*);
`winsertln`(*WINDOW ∗win*);
`wmove`(*WINDOW ∗win*, *int y*, *int*, *x"*);
`wprintw`(*WINDOW ∗win*, *char ∗fmt*, *...*);
`wrefresh`(*WINDOW ∗win*);
`wscanw`(*WINDOW ∗win*, *char ∗fmt*, *...*);
`wstandend`(*WINDOW ∗win*);
`wstandout`(*WINDOW ∗win*);

1. Examples

Here we present a few examples of how to use the package. They attempt to be representative, though not comprehensive. Further examples can be found in the games section of the source tree and in various utilities that use the screen such as *systat(1)*.

The following examples are intended to demonstrate the basic structure of a program using the package. An additional, more comprehensive, program can be found in the source code in the *examples* subdirectory.

1.1. Simple Character Output

This program demonstrates how to set up a window and output characters to it. Also, it demonstrates how one might control the output to the window. If you run this program, you will get a demonstration of the character output chracteristics discussed in the above Character Output section.

```
#include <sys/types.h>
#include <curses.h>
#include <stdio.h>
#include <signal.h>


#define YSIZE 10
#define XSIZE 20

int quit();

main()
{
        int i, j, c;
        size_t len;
        char id[100];
        FILE *fp;
        char *s;

        initscr();                              /* Always call initscr() first */
        signal(SIGINT, quit);                   /* Make sure wou have a ´cleanup´ fn */
        crmode();                               /* We want cbreak mode */
        noecho();                               /* We want to have control of chars */
        delwin(stdscr);                         /* Create our own stdscr */
        stdscr = newwin(YSIZE, XSIZE, 10, 35);
        flushok(stdscr, TRUE);                  /* Enable flushing of stdout */
        scrollok(stdscr, TRUE);                 /* Enable scrolling */
        erase();                                /* Initially, clear the screen */

        standout();
        move(0,0);
        while (1) {
                c = getchar();
                switch(c) {
                case ´q´:                       /* Quit on ´q´ */
                        quit();
                        break;
                case ´s´:                       /* Go into standout mode on ´s´ */
                        standout();
                        break;
```

```
			case ´e´:			/* Exit standout mode on ´e´ */
				standend();
				break;
			case ´r´:			/* Force a refresh on ´r´ */
				wrefresh(curscr);
				break;
			default:			/* By default output the character */
				addch(c);
				refresh();
			}
		}
}


int
quit()
{
		erase();			/* Terminate by erasing the screen */
		refresh();
		endwin();			/* Always end with endwin() */
		delwin(curscr);			/* Return storage */
		delwin(stdscr);
		putchar(´\n´);
		exit(0);
}
```

1.2. Twinkle

This is a moderately simple program which prints patterns on the screen. 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

typedef struct {
		int	y, x;
} LOCS;

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

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

char      *getenv();

int       die();

main()
{
          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;
```

```
                        lp++;
                }
        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();
        }
}
```

Contents