Implementation of VI Editor with NCURSES

What is NCURSES? NCURSES is a clone of the original System V Release 4.0 (SVr4) curses. It is a freely distributable library, fully compatible with older version of curses. In short, it is a library of functions that manages an application's display on character-cell terminals. In the remainder of the document, the terms curses and ncurses are used interchangeably.

A detailed history of NCURSES can be found in the NEWS file from the source distribution. The current package is maintained by Thomas Dickey. You can contact the maintainers at bug-ncurses@gnu.org.

What we can do with NCURSES

NCURSES not only creates a wrapper over terminal capabilities, but also gives a robust framework to create nice looking UI (User Interface)s in text mode. It provides functions to create windows etc. Its sister libraries panel, menu and form provide an extension to the basic curses library. These libraries usually come along with curses. One can create applications that contain multiple windows, menus, panels and forms. Windows can be managed independently, can provide 'scrollability' and even can be hidden.

Menus provide the user with an easy command selection option. Forms allow the creation of easy-to-use data entry and display windows. Panels extend the capabilities of ncurses to deal with overlapping and stacked windows.

These are just some of the basic things we can do with ncurses. As we move along, We will see all the capabilities of these libraries.

Using ncurses library

To compile your C/C++ programs using ncurses/curses library you need to include the curses header file `<curses.h>`. For ncurses, you may include either `<curses.h> or <ncurses.h>`. In some systems, you must include `<ncurses.h>`.

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

To link the programs you need to use the **`-lcurses`** or **`-lncurses`** option, like

```
gcc -lncurses prog.c
```

This way the program is dynamically linked to the ncurses library. To run it in another computer, the system must have the ncurses library installed. If you want to avoid the trouble, you may have it statically linked. To do that, find the file **`libncurses.a`** in **`/usr/lib`** and do

```
gcc prog.c libncurses.a
```

Most Unix systems have curses or ncurses installed as a default option. To find out if it's installed, you can try man ncurses man curses or go to /usr/lib and /usr/include to list the files.

Initialization

The very first thing to do: Before you use any other ***curses*** routines, the `initscr()` routine must be called first.

```
initscr();
```

If your program is going to write to several terminals, you should call `newterm` instead, which is another story.

One-character-a-time. To disable the buffering of typed characters by the TTY driver and get a character-at-a-time input, you need to call

```
cbreak();
```

No echo. To suppress the automatic echoing of typed characters, you need to call

```
noecho();
```

Special keys. In order to capture special keystrokes like **`Backspace`**, **`Delete`** and the four arrow keys by **`getch()`**, you need to call

```
keypad(stdscr, TRUE);
```

Before exiting. Before the program is terminated, **`endwin()`** must be called to restore the terminal settings.

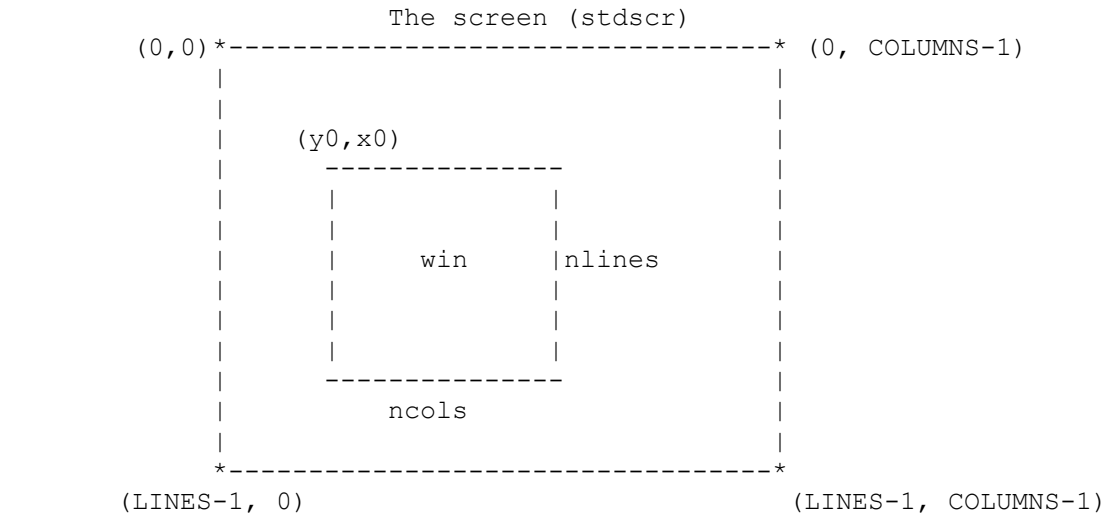
Windows

A window is a 2-dimensional array of characters representing all or part of a CRT screen. Character input and output should pertain to a specific window.

The default window. A default window called **`stdscr`**, which is the size of the terminal screen, is supplied. To use the **`stdscr`** window, you don't need to do any initializations. You can also divide the screen to several parts and create a window to represent each part.

Create a new window. The data structure of window is WINDOW, defined in ncurses.h. To declare and create a new window, do

```
WINDOW * win = newwin(nlines, ncols, y0, x0);
```



All the 4 parameters are `int`s. Here nline is the height of the window -- number of lines, ncols is the width -- number of columns of the window. y0 and x0 are the coordinates of the upper left corner of win on the screen -- line y0 and columns x0. You should make sure that the area of the new window is inside the screen.

Height and width of the window. The size of the whole screen can be determined by the two global variables **`COLUMNS`** and **`LINES`**. **`y0`** and **`x0`** should satisfy

```
0 <= y0 < LINES;
0 <= x0 < COLUMNS;
```

In X window system, the actual xterm size might be changed leaving these two variables obslete. In this case you should use the macro `void getmaxyx(WINDOW *, int y, int x)` to get the size of the screen.

```
int h, w;

getmaxyx(stdscr, h, w);
```

No overlapping. Windows cannot overlap with each other. Therefore you have two options: only use stdscr and no other windows, or create several non-overlapping windows but do not use stdscr.

Refresh. If you make some change to a window, such as printing something or moving the cursor, the effect is not shown on the screen until you call the wrefresh() function

```
wrefresh(win);
```

Clear window. To erase everything written in the window **win**, call **wrefresh(win)**. **refresh()** is equivalent to **wrefresh(stdscr)**.

Delete window. If a window **win** is no longer needed, and you're going to create new windows to overlap it, you should call **delwin(win)** to delete the window (release the memory it is using).

Moving the cursor

The position of the cursor on the screen is important because it is default beginning place for most output functions. The cursor also shows the user where the input is expected.

To move the cursor to a new position on a window, use the function **int wmove(WINDOW *win, int y, int x)**

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

where **(x, y)** are the coordinates of the new position in the window. If the window has **nlines** lines and **ncolumns** columns, then

```
0 <= y < nlines
0 <= x < ncolumns
```

Refresh. The actual cursor motion is not shown on the screen untill you do a **wrefresh(win)**.

move(y, x) is equivalent to the **wmove(stdscr, y, x)**.

Input

To read a character from stdscr, use the function **int getch(void)**.

```
int ch = getch();
```

No echoing. If you have called **noecho()**, the character **ch** will not be printed on the screen, otherwise it will. Disabling automatic echoing gives you more control over the user interface.

No buffering. If you have called **cbreak(void)** each key the user hits is returned immediately by **getch()**. Otherwise the keys hit by the user are queued until a newline is read. Then calls to **getch()** take characters from the queue in FIFO manner until the queue is empty and the next whole line is read.

No delaying. Usually a call to `getch()` waits until a key is hit. If you have called `nodelay(stdscr, TRUE)`, then `getch()` will work in a non-blocking manner -- it will return `ERR` if the key input is not ready. This is usually useful for writing game-like programs, where the promptness of user response matters. For example

```
int ch;
nodelay(stdscr, TRUE);
for (;;) {
     if ((ch = getch()) == ERR) {
         /* user hasn't responded
          ...
         */
     }
     else {
         /* user has pressed a key ch
          ...
         */
     }
}
```

Special keys. If you have called `keypad(stdstr, TRUE)`, then if the user hits a special key such as the `Delete` key, the arrow keys, `Ctrl` combined keys and function keys, a single int value will be returned. Here is the definition of several special keys

```
key code        description

KEY_DOWN        The four arrow keys ...
KEY_UP
KEY_LEFT
KEY_RIGHT
KEY_HOME        Home key
KEY_BACKSPACE   Backspace
KEY_F(n)        Function keys, for 0 <= n >= 63
KEY_DC          Delete character
KEY_IC          Insert char or enter insert mode
KEY_ENTER       Enter or send
```

For a complete list read the man page of `getch()`.

Catch special keys. To use these keys, you need to check the return value of `getch()`. For example

```
int ch = getch();
switch (ch) {
     case KEY_BACKSPACE: /* user pressed backspace */
        ...
     case KEY_UP:  /* user pressed up arrow key */
```

```
        ...
    case KEY_DOWN:  /* user pressed up arrow key */
        ...
    case 'A' ....   /* user pressed key 'A' */
        ...
}
```

Read character from a window. The function `int wgetch(WINDOW *win)`. reads a key from a window. The user input of course comes from the keyboard and not the screen window. But the different windows on the screen might have different delay modes and other properties, therefore affect the behavior of `wgetch()`.

Moving the cursor and read a character. There are also functions which combine cursor moving and character reading together

```
int mvgetch(int y, int x);
int mvwgetch(WINDOW *win, int y, int x);
```

Output

The function `int waddch(WINDOW * win, chtype ch)` adds a character on the window at the current cursor position, and the cursor position is advanced then.

Wrap. If the new position of the cursor is out of the window, it wraps to the beginning of the next line.

Scroll. If the next line is out of the window, and you have called `scrollok(win, TRUE)` when the window was created, the stuff in the window is scrolled up one line.

Character attribute. The parameter `ch` is of type `chtype()`, which is the ASCII value of the character combined with some video attributes such as colors. The combination is through the logical OR of the character value and the attribute, which I will talk about in the section.

Refresh. After a call to `waddch`, the screen is not updated until you call `wrefresh(win)`.

Ohter output functions

`mvwaddch(win, y, x, ch);` is equivalent to `wmove(win, y, x); waddch(win, ch);`

`addch(ch);` is equivalent to `waddch(stdscr, ch);`.

`wechochar(win, ch);` function and `echochar(ch)` are equivalent to `waddch(win, ch); wrefresh(win);` and `addch(ch); refresh();`respectively.
But `echochar` and `wechochar` may be more efficient.

`int waddstr(WINDOW *win, const char *str)` and `int addstr(const char *str)` prints a null-terminated string at the cursor position of the window, and advance the cursor position accordingly.

The functions `int wprintw(WINDOW *win, char *fmt ...)` and `int printw(char *fmt ...)` do formatted output in the same fashion as the analogous standard library function `printf`.

Attribute

When characters are drawn on the screen some special video effects, like *foreground and background color*, *highlight*, *underline*, *blinking*, ..., can be shown. Such video effects are represented by integers called text attributes. Each significant bit of the attribute corresponds to one video effect.

Using attribute

There are two ways to use attribute. One is by passing `waddch(win, ch)` a character value combined with attribute. The other is setting the global window attribute.

Character type. When calling `waddch(win, ch)` or `addch(ch)`, logical OR the character value with the attribute. For example, `A_UNDERLINE` is the predefined attribute for underlining. To print the character **'X'** with underlining, do

```
waddch(win, 'X' | A_UNDERLINE);
```

Using several attributes is of course possible. For example, to To print the character **'X'** with highlight in color pair 3

```
waddch(win, 'X' | A_UNDERLINE | COLOR_PAIR(3));
```

Setting window attribute. `int wattron(WINDOW *win, int attr)` function to turn on an attribute `attr`. Then anything printed by subsequent calls to `waddch`, `addstr` and `waddstr` will have the attribute `attr`, For example, to print a highlighted message on the screen

```
attron(A_STANDOUT);
addstr("I am highlighted!\n");
```

Predefined attributes. Here is some attributes defined in ncurses.h

```
A_NORMAL        Normal display (no highlight)
A_STANDOUT      Best highlighting mode of the terminal.
A_UNDERLINE     Underlining
A_REVERSE       Reverse video
A_BLINK         Blinking
A_DIM           Half bright
A_BOLD          Extra bright or bold
A_PROTECT       Protected mode
A_INVIS         Invisible or blank mode
A_ALTCHARSET    Alternate character set
A_CHARTEXT      Bit-mask to extract a character
COLOR_PAIR(n)   Color-pair number n
```

Using colors

The combination of foreground and background color is an attribute. Unlike other attributes, before using colors, you must call `start_color()`.

When `start_color()` is called, a set of *colors* and *color pairs* are created which you can use. The number of available colors and the number of the color pairs are stored in two global variables `COLORS` and `COLOR_PAIRS`. To use an predefined color pair as an attribute, you need to cal the macro`COLOR_PAIR(n)`, where `n` must satisfy

```
0 <= n < COLORS
```

Example. To give a window the color attribute defined by color pair #2, so that each subsequent character printed in this window has the foreground and background color defined by color pair #2

```
wattron(win, COLOR_PAIR(2));
```

The meaning of a color pair can be redefined. For example

```
init_pair(1,2,0);
```

redefine the color pair #1 with foreground color #2 and background color #0. In the function `int init_pair(short n, short f, short b)` the parameters must satisfy

```
0 <= n < COLORS
0 <= f < COLOR_PAIRS
0 <= b < COLOR_PAIRS
```

When `start_color()` is called, 8 basic colors are initialized

```
COLOR_BLACK
COLOR_RED
COLOR_GREEN
```

```
COLOR_YELLOW
COLOR_BLUE
COLOR_MAGENTA
COLOR_CYAN
COLOR_WHITE
```

You can use these names in `init_pair()` for specifying foreground and background color.

To find out what foreground color and background color is used by a color pair, use the function `int pair_content(short pair, short *f, short *b)`. To find out the definition of a color use the function `int color_content(short color, short *r, short *g, short *b)`

Color can also be redefined by `int init_color(short n, short r, short g, short b)`, where n is the index of color, must be less than COLORS. r, g, and b represent the intensity of red, green and blue. Each value of r, g and b must be less than 1000.

Line graphics

Line graphics. Here are some special characters which can be used in addch and addstr routines as the chtype.

```
ACS_BLOCK               solid square block
ACS_BOARD               board of squares
ACS_BTEE                bottom tee
ACS_BULLET              bullet
ACS_CKBOARD             checker board (stipple)
ACS_DARROW              arrow pointing down
ACS_DEGREE              degree symbol
ACS_DIAMOND             diamond
ACS_GEQUAL              greater-than-or-equal-to
ACS_HLINE               horizontal line
ACS_LANTERN             lantern symbol
ACS_LARROW              arrow pointing left
ACS_LEQUAL              less-than-or-equal-to
ACS_LLCORNER            lower left-hand corner
ACS_LRCORNER            lower right-hand corner
ACS_LTEE                left tee
ACS_NEQUAL              not-equal
ACS_PI                  greek pi
ACS_PLMINUS             plus/minus
ACS_PLUS                plus
ACS_RARROW              arrow pointing right
ACS_RTEE                right tee
ACS_S1                  scan line 1
ACS_S3                  scan line 3
ACS_S7                  scan line 7
ACS_S9                  scan line 9
ACS_STERLING            pound-sterling symbol
ACS_TTEE                top tee
ACS_UARROW              arrow pointing up
ACS_ULCORNER            upper left-hand corner
```

```
ACS_URCORNER            upper right-hand corner
ACS_VLINE               vertical line
```

Usually on terminals using these symbols can draw pretty windows and shapes. One place to use this is the **wborder** function, which draws borders for a window. See the man page for details about the parameters, but usually do it the following way

```
wborder(win, 0, 0, 0, 0, 0, 0, 0, 0);
```

will make a good looking window.

To draw a horizontal line across the window, do

```
whline(win, ACS_HLINE, ncolumns);
```

Example 1. The Hello World !!! Program

```
#include <ncurses.h>

int main()
{
        initscr();                      /* Start curses mode
*/
        printw("Hello World !!!");      /* Print Hello World
*/
        refresh();                      /* Print it on to the real screen
*/
        getch();                        /* Wait for user input */
        endwin();                       /* End curses mode
*/

        return 0;
}
```