MENWIZ

Character LCD menu library for Arduino

© 2012 By Roberto Brunialti
roberto.brunialti@knowcastle.com

SUMMARY

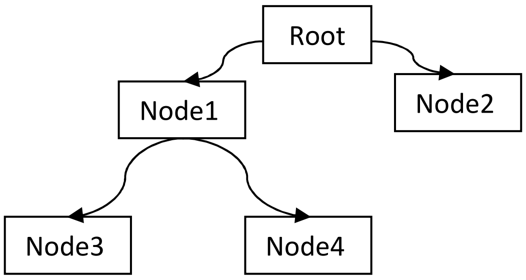
1. MENWIZ: A QUICK TOUR

1.1 Background

WARNING: This chapter is a little bit theoretical. You can skip it and pass directly to the second chapter. Neverthless I suggest you to read it at some point, as it gives you the background perspective of the library and what you can expect from it now and in the future.

Technically we can define a menu as a not oriented acyclic graph, that is a hierarchical tree where all nodes are (sub)menu.

In MENWIZ all nodes are equal except one: the root. All the menu trees starts from a single node called root. There must be one and only one root node for each menu hierarchy (that is an instance of `menwiz` class in MENWIZ). Each node must declare its "parent node", that is the ancestor node that must be traversed in order to reached the node itself. The parent nod of a root node is the root node itself. The root node must be declared as first node in MENWIZ.



In the above image "Root" is the parent node of "Node1", and "Node1" is parent of "Node 3" and "Node 4".

In MENWIZ each node is an instance of class `_menu` , even the root node. All nodes have at least one attribute: a label, that is the character string that appear on the LCD. In this example we assume label to be the text inside the node box ("Root","Node1", …).

All nodes within a menu tree are created using the following method of the class `menwiz`

```
      addMenu(qualifier, parent node, label);
```

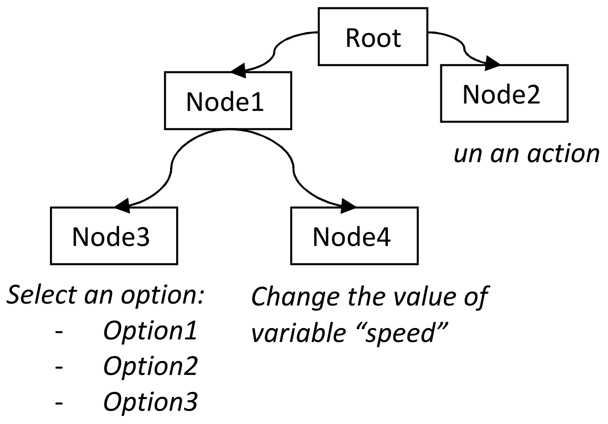
In a menu structure some nodes are nothing else than containers of other child nodes. They have the only function to "organize" the different menu levels, with no contents other than the label and no specific behavior. In the example "Root", and "Node1" are such a type of nodes.

Any node having "child" nodes belongs to one of the following types (defined at creation time using `addMenu` method):

- root note; a root node is the first node to be created ; it is defined as root using the qualifier `MW_ROOT` at creation time; there is only one root node in a menu tree
- submenu, a node that has child and that is not a root node; it is defined as a submenu using the qualifier `MW_SUBMENU` at creation time

assume that once a user arrives ("navigates") to a terminal node, he likely wants to make something more than simply going up and forth in a tree structure, for instance: selecting one of multiple options, setting/changing a variable value, running an action and so on.

In MENWIZ terminal nodes can be enriched with attributes and behaviours other than a simple label. Returning to the the example, we want add some behaviors to our terminal nodes:



To reach our goal, any terminal node must have an associated user variable, in order to let the application (sketch code) be aware of the user interaction with the menu. This is done in MENWIZ binding a standard user variable to the terminal node: any change the user makes during menu interaction is available to the sketch code thru that variable and vice-versa (any change to the variable value done inside the sketch is available to the menu);

So we can say that in MENWIZ any terminal node:

- must be esplicitly declared as terminal node at creation time using the qualifier `MW_VAR` as argument.
- must be associated to a menu variable and binded to a user defined variable with the following method of class _menu:

```
addVar(variable type, binding variable, ….);
```

`MW_LIST`	a list of option to choose between
`MW_BOOLEAN`	a boolean value the user can toggle on/off
`MW_AUTO_INT`	an integer value, with min/max boundaries and increment/decrement step
`MW_AUTO_FLOAT`	a floating value, with min/max boundaries and increment/decrement step

MW_AUTO_BYTE	a byte value, with min/max boundaries and increment/decrement step
MW_ACTION	a user defined function to be called when the user push the enter button inside the menu terminal node

for any variable type there is a specific syntax of the method `addVar` :

```
void addVar(int, int*);                          // type MW_LIST
void addVar(int, int*, int, int, int);           // type MW_AUTO_INT
void addVar(int, float*, float, float, float);  // type MW_AUTO_FLOAT
void addVar(int, byte *,byte ,byte ,byte);      // type MW_AUTO_BYTE
void addVar(int, boolean *);                     // type MW_BOOLEAN
void addVar(int, void (*f)());                   // type MW_ACTION
```

All the above menu variables (except the `MW_ACTION`) have a user defined binded variable (second function argument) the sketch code can check and/or change.

1.2 Lets go to the code, finally !

Library to include

```
#include <Wire.h>
#include <LCD.h>
#include <LiquidCrystal_I2C.h>
#include <buttons.h>
#include <MENWIZ.h>
```

MENWIZ uses the “new” LiquidCrystal Library by Francisco Malpartida. This library supports I2c, 4, 8 wires and other lcd devices.
An other library needed by MENWIZ is the compact Buttons library by Franky.
Both of themare priveded inside the library package and must be installed before to use MENWIZ.

Global variables to create

In this example I use a 20x4 lcd. The creation of the lcd object syntax depends from your device’s interface (I2C, 4w, 8w ,…).

```
LiquidCrystal_I2C lcd(0x27, 2, 1, 0, 4, 5, 6, 7, 3, POSITIVE);
menwiz tree;      //menwiz object
int  list,sp=110; // sp variable has 110 as default value
_menu *r,*s1,*s2; //ptr to nodes to be created (1 for each level)
```

Code required to create the menu structure

```
  r=tree.addMenu(MW_ROOT,NULL,"Root");
    s1=tree.addMenu(MW_SUBMENU,r,"Node1");
      s2=tree.addMenu(MW_VAR,s1,"Node3");
        s2->addVar(MW_LIST,&list);
        s2->addItem(MW_LIST,"Option1");
        s2->addItem(MW_LIST,"Option2");
        s2->addItem(MW_LIST,"Option3");
      s2=tree.addMenu(MW_VAR,s1,"Node4");
```

```
        s2->addVar(MW_AUTO_INT,&sp,0,120,10);
    s1=tree.addMenu(MW_VAR,r,"Node2");
      s1->addVar(MW_ACTION,myfunc);
```

Declare navigation devices (buttons …)

Menus navigaton needs a set of push buttons. MENWIZ let available to the user two options. The first requires 6 pin numbers (for the following buttons: up, down, left, right, escape, enter) to be passed to the following method of the class `menwiz`:

```
navButtons(int,int,int,int,int,int);
```

- up and down buttons allow to navigate menus and options;
- left and right buttons allow to increase/decrease variable values;
- escape button return one upper level back without saving changes;
- return button acts as escape, saving the changes.

The same function can be called with only four arguments (up,down,escape, enter). In this simple interface changes are not subject to confirmation, as they take effect immediately. To increment/decrement variables values are used the up and down button.
There is also a third option: the user can provide its own callback routine if has more sophisticated input custom devices. The user provided function overload the internal one. This “advanced” option is out of the scope of this tutorial.
The line code to be inserted in the example is the long version (6 buttons), as the following (pin number is of course user defined):

```
tree.navButtons(9,10,7,8,11,12);
```

Few more lines to refine the example

The action fired under the menu node and labeled as “Node2” is part of the sketch. Let inser a trivial function writing to the serial terminal

```
void myfunc(){
  Serial.println(“ACTION FIRED!”);
  }
```

How to debug

It is strongly suggested, during debugging, to use the following function call after each MENWIZ function call in order to check if any error occourred during last MENWIZ library call:

```
int getErrorMessage(boolean fl);
```

the function is a method of class `menwiz`. It returns 0 if no errors occourred, an error code otherwise. If `fl` arg is equal to true `true`, the function output error messages (if any) to the serial monitor. If `fl` is set to `false`, the function only returns the error code.
An other usefull function to check available sram memory is the following method of class `menwiz`:

```
int freeMem();
```

it returns the available sram bytes. You can used to check if unpredictable behaviours of your code are due to exhausted emory problems.

All together now ! We can now assemble the whole example

```
//The full code is in library example file Quick_tour.ino
#include <Wire.h>
#include <LCD.h>
#include <LiquidCrystal_I2C.h>
#include <buttons.h>
#include <MENWIZ.h>

// DEFINE ARDUINO PINS FOR THE NAVIGATION BUTTONS
#define UP_BOTTON_PIN       9
#define DOWN_BOTTON_PIN     10
#define LEFT_BOTTON_PIN     7
#define RIGHT_BOTTON_PIN    8
#define CONFIRM_BOTTON_PIN  12
#define ESCAPE_BOTTON_PIN   11

menwiz tree;
// create lcd obj using LiquidCrystal lib
LiquidCrystal_I2C lcd(0x27, 2, 1, 0, 4, 5, 6, 7, 3, POSITIVE);

int  list,sp=110;

void setup(){
  _menu *r,*s1,*s2;

  Serial.begin(19200);
  tree.begin(&lcd,20,4); //declare lcd object and screen size to menwiz lib

  r=tree.addMenu(MW_ROOT,NULL,"Root");
    s1=tree.addMenu(MW_SUBMENU,r,"Node1");
      s2=tree.addMenu(MW_VAR,s1,"Node3");
        s2->addVar(MW_LIST,&list);
        s2->addItem(MW_LIST,"Option1");
        s2->addItem(MW_LIST,"Option2");
        s2->addItem(MW_LIST,"Option3");
      s2=tree.addMenu(MW_VAR,s1,"Node4");
        s2->addVar(MW_AUTO_INT,&sp,0,120,10);
    s1=tree.addMenu(MW_VAR,r,"Node2");
      s1->addVar(MW_ACTION,myfunc);

tree.navButtons(UP_BOTTON_PIN,DOWN_BOTTON_PIN,LEFT_BOTTON_PIN,RIGHT_BOTTON_PIN,E
SCAPE_BOTTON_PIN,CONFIRM_BOTTON_PIN);
  }

void loop(){
  tree.draw();
  }

void myfunc(){
  Serial.println("ACTION FIRED");
  }
```

1.3 “Advanced” functions

Quick way to draw an entire formatted screen with one function

```
void drawUsrScreen(char *str);
```

This is a method of class `menwiz.` `str` argument is a string containing all the multiline text to be displayed on the LCD. Each display line inside `str` to must be terminated by char 0x0A ('\n') . This method provide the user with a quick way to write an entire LCD screen (the lib will manage space padding, cursor position and string length checking). This function can be used in any point of the sketch code. Remember that the persistence of the text on LCD is within a single call of method `draw().` A new call to the method `draw()` will overwrite the LCD.

Example:
```
drawUsrScreen("Test user screen\nline1\nline2\n\n");
```

The above call let the lcd display the four line user defined screen. The last line is empty.

Temporized default screens (splash and default screens)

MENWIZ allows the user to define two optional temporized “default” screen:

Splash screen
the one to be shown at startup time for a certain amount of seconds. It is asynchronous, that is during the splash screen the sketch can execute other code. The method of the class menwiz is as following:

```
void     addSplash(char *str, int msecs);
```

`str` argument is a string containing all the multiline text to be displayed on the LCD. Each display line inside `str` to must be terminated by char 0x0A ('\n') . The argument `msecs` contains the splash screen duration in millisecs. The method manages space padding, cursor position and string length checking).

Default screen:
the one to be shown after a certain number of seconds since the last user ‘s menu interaction and until any interaction with the navigation buttons. It is usefull , for instance, when a sketch need to continuosly show values from sensors and the menu use is a rare event. The method of the class menwiz is as following:

```
void     addUsrScreen(void (*f)(), unsigned long elapsed);
```

`f` argument is the user defined void function (callback) called after `elapsed` millisecs from the last interaction with the menu. Inside `f` callback the user can read sensor values, perform its own task and compose its own screen. The callback is fired once for each `draw()` method call, allowing fast data refreshing to be displayed.
It is usefull to use the method `drawUsrScreen` to display a formatted screen inside the `f` callback.

Internal variables and memory limits

In order to limit the allocated memory amount, the library preallocates some array able to manage up to a maximum number of menu items (nodes) and/or options or submenus.

Those limits can be modified by the user, changing some literals in the MENWIZ.h file. Any change to the predefined values affects the memory usage.

```
#define MAX_MENU 15
```

This literal define the max number of nodes. It is equal to the maximum number of call to the `addMenu` methods. When the method `addMenu` is called a number of times greater than `MAX_MENU` value, the function *`getErrorMessage(true)` return the value 100 and the following message is sent to the serial terminal: "E100-Too many items. Increment MAX_MENU".*

#define MAX_OPTXMENU 5

This literal define the max number of options (see `addItem` method) within an option list and the max number of submenus (child nodes) of a single node (see `addMenu` method with `MW_SUBMENU ARG`). If the above methods are used a number of times greater than `MAX_OPTXMENU` value, the function *`getErrorMessage(true)` return the value 105 and the following message is sent to the serial terminal: "E105-Too many items. IncremenT MAX_OPTXMENU".*

#define MAX_BUFFER 84

This literal defines the internal LCD max buffer sizes. The value must be uqual or greater than the value calculated as following: MAX_BUFFER>= LCD columns x LCD rows + rows. The default value is able to manage a LCD up to 4 rows of 20 characters each.

How to use your input devices instead of standard digital buttons

if you want to use your own device to replace the standards buttons managed by MENWIZ and Buttons libraries (and declared with `navButtons` functions) you need to write your own function and to declare it to MENWIZ library using `addUsrNav` method.
The user defined function will replace the following internal one:

```
int menwiz::scanNavButtons(){
  if(btx->BTU.check()==ON){
    return MW_BTU;}
  else if (btx->BTD.check()==ON){
    return MW_BTD;}
  else if (btx->BTL.check()==ON){
    return MW_BTL;}
  else if (btx->BTR.check()==ON){
    return MW_BTR;}
  else if (btx->BTE.check()==ON){
    return MW_BTE;}
  else if (btx->BTC.check()==ON){
    return MW_BTC;}
  else
    return MW_BTNULL;
  }
```

The user defined function must return one of the following integer values, defined in MENWIZ.h:

```
// BUTTON CODES
// ----------------------------------------------------------------------
#define MW_BTNULL      30   //NOBUTTON
#define MW_BTU         31   //UP
#define MW_BTD         32   //DOWN
#define MW_BTL         33   //RIGTH
#define MW_BTR         34   //LEFT
#define MW_BTE         35   //ESCAPE
#define MW_BTC         36   //CONFIRM
```

The returned integer code represent the last pushed button, if any, or `MW_BTNULL` if no button has been pushed since last call.
The user defined function, as the internal `scanNavButtons`, is called once for every time the method `menwiz::draw` is called.
The returned code will activate the behavior associated to the pushed button (or no behaviour if no button has been pushed).
<u>Resuming</u>
in case of any custom device (as analog button or any other) you must:
- write your own function in the sketch (the name is up to the user)
- the function must return one of the 7 values above, depending on the pushed button (or the simulated ones)
- the function must be declared to MENWIZ with the method `addUsrNav`

2. MENWIZ changes history

Ver 0.5.0

Changes to existing functions

`void navButtons(int up, int down, int esc, int enter);`

method of class `menwiz.` Now MENWIZ works with only 4 buttons also (you can use both way: the old one with 6 buttons and the new one with only 4). Each argument is the Arduino pin used by the related button.

Remember:
[Up] button in variable context: increment the variable value
[Down] button in variable context: decrement the variable value
In other context up/Down buttons acts as usual (screen scrolling).
ALLOWED USER DEFINED BUTTON MANAGEMENT CALLBACK (addUsrNav) MUST STILL RETURN 6 VALUES (BUTTONS)!

Ver 0.4.1

Changes to existing functions

`void addVar(int,float *,float,float,float);`

method of class `_menu.` now MENWIZ supports variables of floating point type (MW_AUTO_FLOAT). The variables are displayed with a nember of decimal digits set by MW_FLOAT_DEC global variable (default=1). The syntax is the same as integer type (MW_AUTO_INTEGER).

Example:
```
float gp;
menu.addVar(MW_AUTO_FLOAT,&gp,11.00,100.00,0.5);
```

the above call create a variable of type float, binded to sketch variable gp, ranging between 11,0 and 100,0, with increment of 0,5

`void addVar(int,byte *,byte,byte,byte);`

method of class `_menu.` now MENWIZ supports now also variables of byte type (MW_AUTO_BYTE). The syntax is the same as integer type (MW_AUTO_INTEGER).

Example:
```
byte gp;
menu.addVar(MW_AUTO_BYTE,&gp,0,255,1);
```

the above call create a variable of type byte, binded to sketch variable gp, ranging between 1,0 and 255, with increment of 1

Internal changes

added the global variable `MW_FLOAT_DEC` setting the number of decimal digits of floating variables (default=1);

Ver 0.3.0 CHANGES

Changes to existing functions

void addSplash(char * str, int millisecs);

method of class `menwiz. Str` passed to the function use \n (0x0A) character as line delimiter instead of previous character '#'

New functions

void addUsrNav(int (*f)());

method of class `menwiz` . `f` is the uswer defined navigation routine (callback). The user can use any device other than buttons to overwrite the internal routine. The callback *must* return an int code for any pushed "button" (MW_BTU=UP, MW_BTD=DOWN, MW_BTL=LEFT, MW_BTR=RIGHT, MW_BTE=ESCAPE, MW_BTC=CONFIRM, MW_BTNULL=NO BUTTON).
The callback is invocated on each call to the method draw. The used device(s) must be declared and initialized inside the sketch by the user. The callback is in charge of device debouncing (if any).

void drawUsrScreen(char *str);

method of class `menwiz` . It quick draw LCD screen with the contents of the argument string. Each line to be shown in the LCD is terminated by char 0x0A ('\n') inside the argument string. This method provide the user with the quick way to write an entire LCD screen (the lib will manage space padding, cursor position and string length checking).

Example:
```
menu.drawUsrScreen("Test user screen\nline1\nline2\n\n");
```

The above call let the lcd display the four line user defined screen. The last line is empty.

int getErrorMessage(boolean fl);

method of class `menwiz` . if `fl` is `true`, the function write a full error message to the default serial terminal, otherwise return error code only