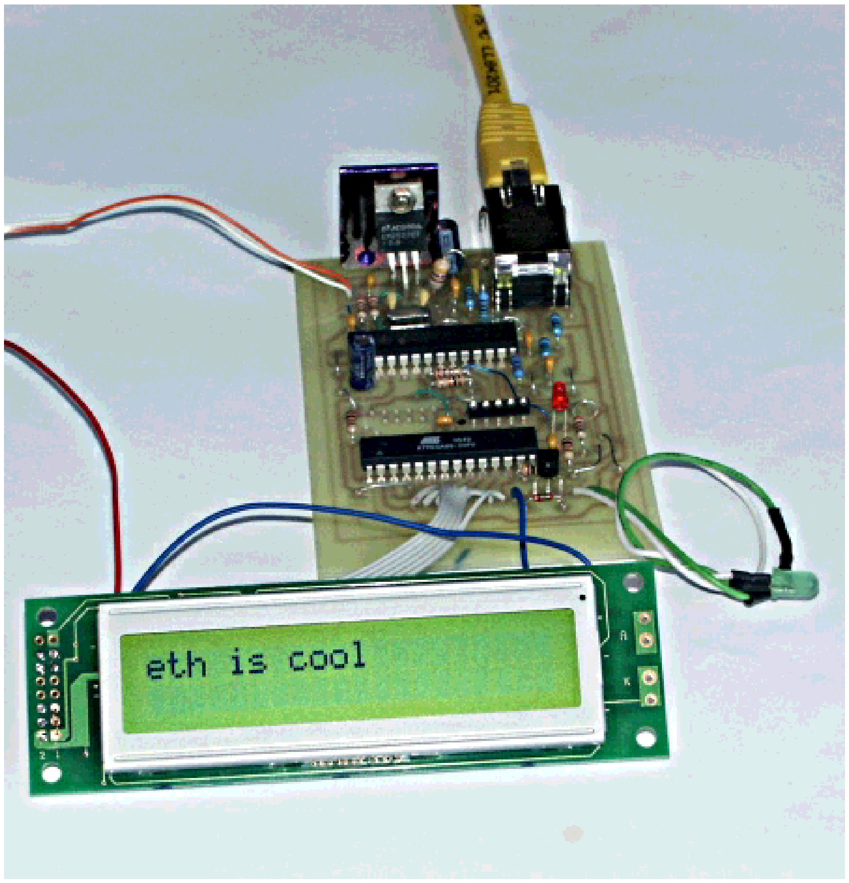
Content:

By Guido Socher (homepage)

A LCD display with ethernet interface



Abstract:

In this article a LCD display is added to the already existing ethernet board. The related articles which describe how to build the AVR web server are here:

1. An AVR microcontroller based Ethernet device
2. HTTP/TCP with an atmega88 microcontroller (AVR web

server)

The components for building this avr web server with LCD interface can be ordered from http://shop.tuxgraphics.org

Why a LCD display?

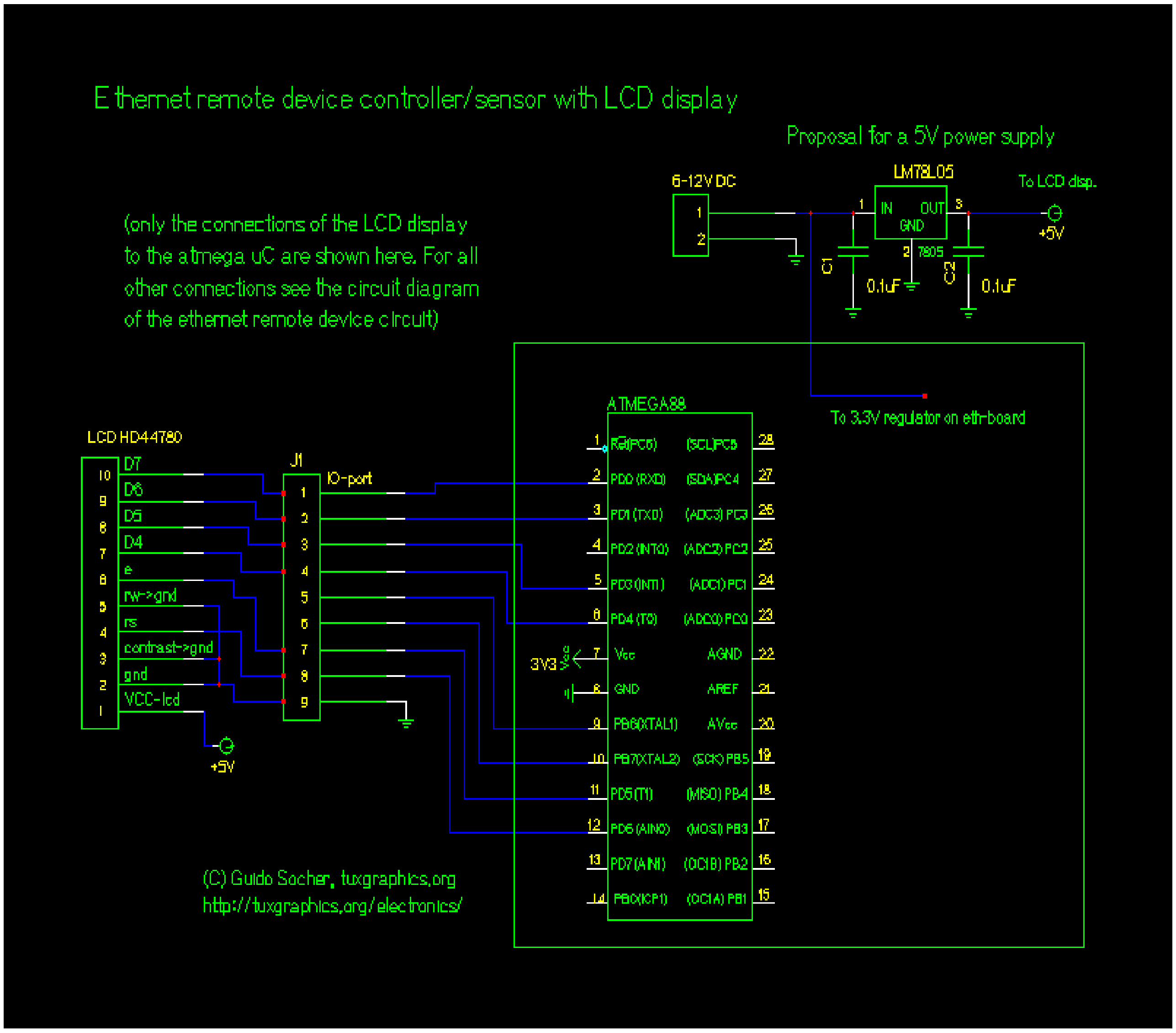
Originally I wanted to write the next article about a weather station based on the avr web server. Based on a request from a customer I decided then to develop this circuit first. The weather station comes next. There are a number of interesting aspects/problems here which could also be useful for developing other circuits.

- Most LCD displays want 5V. The avr web server uses 3.3V
- The simple "switch on/off a relay" circuit which was the only function provided by the avr web server until now did not require HTML-forms. I used simply 2 URLs http://baseurl/password/1 for switching on and http://baseurl/password/0 for switching off. This does not work anymore for the display as we want to type a text into a web page which should then be shown on the display. What is needed is a needed is a proper decoding of HTML form data.

The circuit

Most HD44780 compatible displays need 5V DC. The 5V are however mainly needed to get contrast on the display right and to power the chips on the board. On the data lines those displays work also with 3V signals without any problems. In other words it should be no problem to attach the display to the general purpose IO-port of our avr web server ("ethernet remote device"). The display will be able to handle the 3.3V signals coming from the atmega chip. How about the other direction? The atmega can work with 5V signals but only if it is also powered with 5V. Any voltages above 3.3V would go into the atmega internal over voltage protection diodes and if the current is too high it would damage them. A 100 Ohm resistor in series could solve the problem. However how many output pins does a HD44780 display have? This depends on the RW line. If we pull RW to GND then all lines will be input lines on the LCD side. The LCD driver code can then not ask the display "are you ready?" but that is generally not a problem. The driver can just wait a few milliseconds and the display will have completed the command.

In other words the display can be connected straight to the ethernet board without additional parts we just need 5V VCC for the LCD display.


Ethernet remote device controller/sensor with LCD display
Proposal for a 5V power supply
LM78L05
6-12V DC
To LCD disp.
+5V
0.1uF
0.1uF
C1
C2
7805
(only the connections of the LCD display to the atmega uC are shown here. For all other connections see the circuit diagram of the ethernet remote device circuit)
ATMEGA88
To 3.3V regulator on eth-board
LCD HD44780
J1
IO-port
D7
D6
D5
D4
e
rw->gnd
rs
contrast->gnd
gnd
VCC-lcd
3V3
(C) Guido Socher, tuxgraphics.org
http://tuxgraphics.org/electronics/

Click on the image to view the circuit as pdf file

The web interface

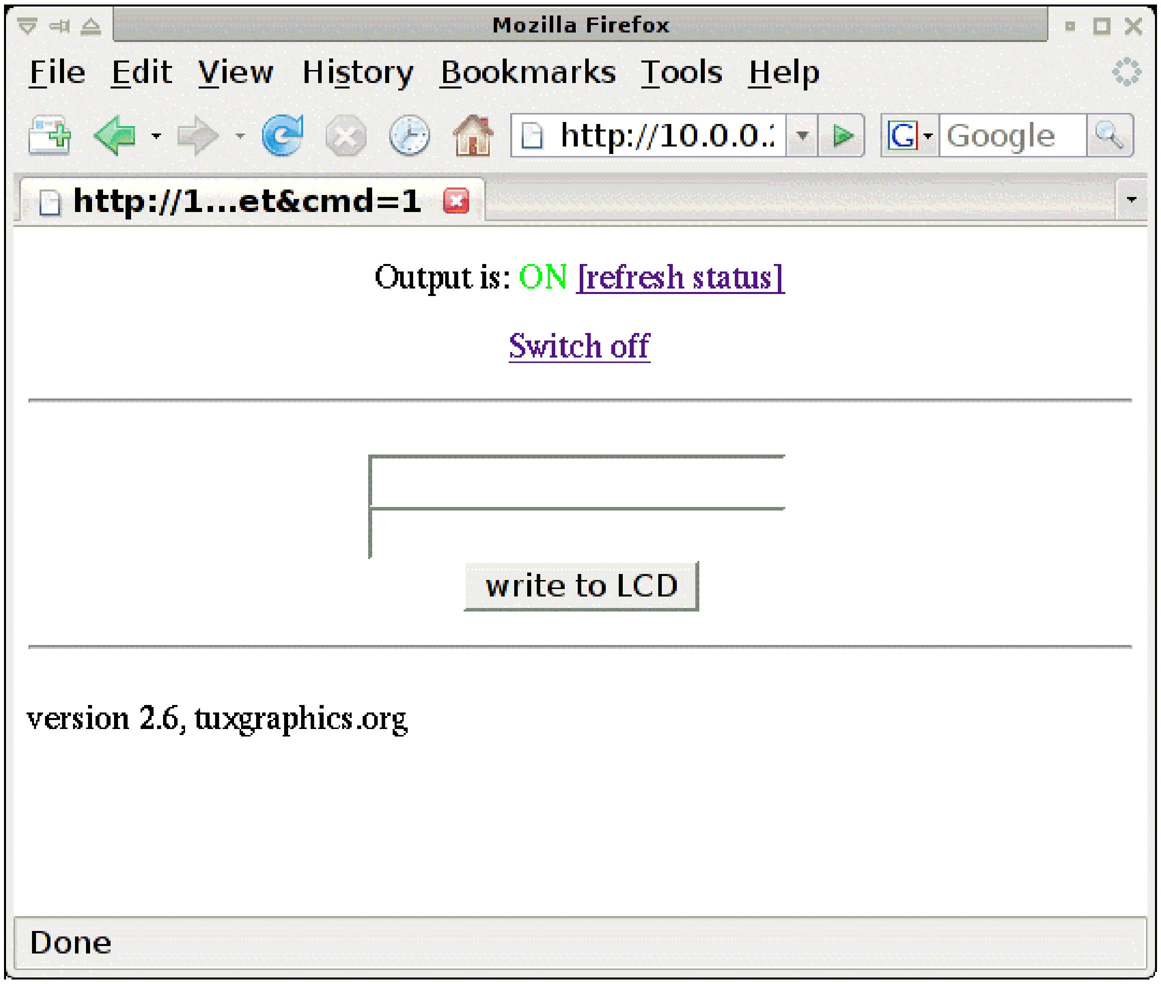
The web page that the avr web server will display is again clean and simple with no unnecessary HTML code. To be able to enter text lines a HTML form is needed. Something like this:

```
<form  METHOD="get" action="http://10.0.0.24/q">
<input type="hidden" name="cmd" value="2">
<input size="20" type="text" name="l1"><br>
<input size="20" type="text" name="l2"><br>
<input type="submit" value="write to LCD">
</form>
```

We use the HTML "get" method. In other words the data we enter into the form arrives at the atmega chip again as a URL but some characters will have a bit strange encoding. A single space character will e.g be encoded either as "%20" or as "+" dependent on the type of web browser you use.

The cmd parameter is used to branch in the code: cmd=0 or cmd=1 is used to switch off/on the optional relay and cmd=2 means "update the text on the display".

This is how the web page looks like in firefox:



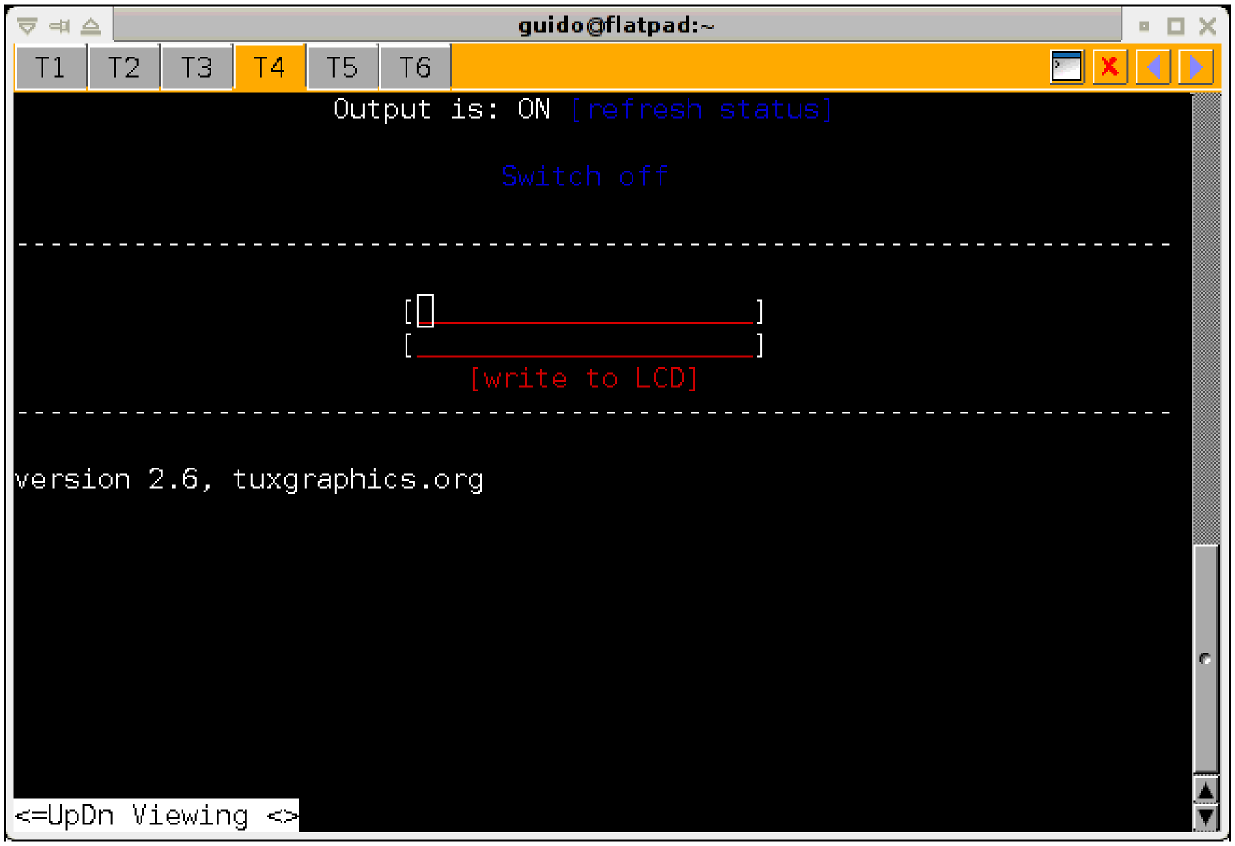
Output is: ON [refresh status]

Switch off

write to LCD

version 2.6, tuxgraphics.org

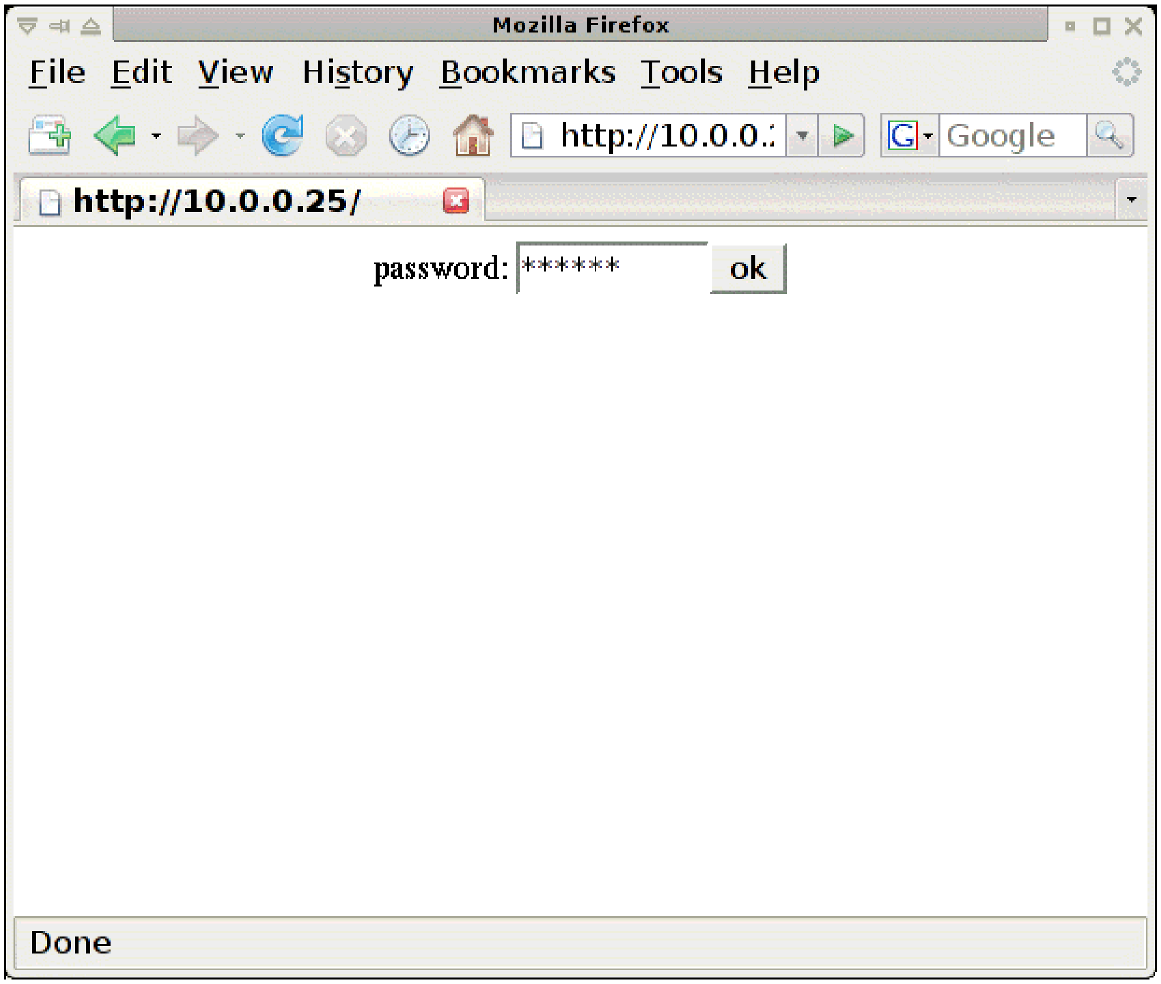
... and in a w3m text terminal web browser:



```
                   Output is: ON [refresh status]

                             Switch off

----------------------------------------------------------------------

                       [_____________________]
                       [_____________________]
                           [write to LCD]
----------------------------------------------------------------------

version 2.6, tuxgraphics.org
```

```
<=UpDn Viewing <>
```

... to have some basic access control there is a login page displayed before you enter the main page:



As you can see the "switch on/off a relay" functionality is still there. The LCD is just an add-on. You can however remove the "switch on/off a relay" easily if you don’t need it.

URL-decoding and other building blocks

The main point about free software is not so much that it is free of charge but that it provides the sources and therefore access to the building blocks. You can just take those building blocks and use them for your own ideas.

The code is available for download at the end of this article.

All smaller functions can be found in the file main.c. This is also where you should start reading if you want to understand the code.

URL decoding

This implemented in file main.c in function "void urldecode(char *urlbuf)". It takes an URL encoded string and decodes it. It modifies the string buffer handed to the function. Decoded strings are always shorter than URL encoded strings. It needs the helper function h2int() which converts a single hex digit into an integer.

```
// decode a url string e.g "hello%20joe" or "hello+joe" becomes "hello joe"
void urldecode(char *urlbuf)
{
        char c;
        char *dst;
        dst=urlbuf;
        while ((c = *urlbuf)) {
                if (c == '+') c = ' ';
                if (c == '%') {
                        urlbuf++;
                        c = *urlbuf;
                        urlbuf++;
                        c = (h2int(c) << 4) | h2int(*urlbuf);
                }
                *dst = c;
                dst++;
                urlbuf++;
        }
        *dst = '\0';
}
```

Finding Key value pairs from the HTTP "GET" method

If you have a web-form with a text field like

```
<input size="20" type="text" name="l2">
```

Then this arrives a the HTTP protocol level as something like
q?l2=TheTextYouTyped&OtherKey=OtherValue HTTP/1.1\r\n
We need a function to extract those key/value pairs (key=l2 and value=TheTextYouTyped in the above example). One could either write a function that runs through the string once and stores the key/value pairs somewhere or one that searches for just one key and extracts the value. The first solution needs more memory to store all the key/value pairs and the later costs more computing time as it needs to run through the string every time. It's more important to save memory (the atmega88 has 1K ram) therefore the later function is the better choice.
The function
uint8_t find_key_val(char *str,char *key) // in file main.c
take as first argument such a url-sting and searches for a key. If a value is found then it is returned in the static "strbuf" string buffer.

Interfacing the LCD

- lcd.c -- the main code for handling HD44780 displays, don't modify it.
- lcd.h -- the functions you can use. E.g: lcd_clrscr() to clear the screen. lcd_gotoxy() to go to a certain row or character position. lcd_puts() to write a string to the display.
- lcd_hw.h -- the hardware definitions. To which pins the display is connected on the avr microcontroller.

Those are the main add-on blocks for things which are new here. All other functions used are the same as in the normal avr web server code.

Control via scripts

The web server displays a web page. That page is meant for humans to enter the data. If you want a machine interface to use this e.g from a different application then this might not be the best choice. We use however the HTTP "get" method and this provides automatically an easy to use machine interface. The the command line web browser w3m (http://sourceforge.net/projects/w3m/) can be used for that.

All commands need a password (default value is "secret"):
pw=secret
and a command e.g to switch on the relay:
cmd=1
Now you just put this together and use it via w3m:

```
w3m -dump "http://10.0.0.24/q&pw=secret&cmd=1"
```

To write something to the first display line the command is cmd=2 and the text comes after l1:
l1=DisplayText
Now you just put this together and use it via w3m:

```
w3m -dump "http://10.0.0.24/q&pw=secret&cmd=2&l1=DisplayText"
```

This writes "DisplayText" onto the LCD. DisplayText needs to be URL encoded. The most important characters to know here are "&" which becomes "%26" and a single space which becomes "+" in URL format.

What to do with an avr web server and an attached LCD display?

Now you might ask "what to do with it ?". There are all kind of uses for small LCD displays. People attach them via usb/rs232 or parallel port to computers. This one is attached via ethernet. The advantage of ethernet is that you can have a much longer cable. It does not have to be near the computer as in the case of usb/rs232 or parallel port.

The display keeps the text even if the computer which sent the text to that display is already detached from the net. You could use it as a fancy electronic door plate or notice board in your office.

As you can see there are many things one can do with it. The most important point is perhaps that you have also the source code and you can change and modify it slightly.

There is however one thing you should remember. The hardware looks almost like a "complete computer" with just the keyboard missing. Display, RAM and CPU, everything is there. That is however an illusion. It’s not even nearly a full PC. It’s mainly a LCD display with an ethernet cable.

Download and links

- **Download** page for this article: software and updates
- The previous article with the avr web server software (eth_rem_dev_tcp-2.X.tar.gz):

HTTP/TCP with an atmega88 microcontroller (AVR web server).

- The tuxgraphics shop: shop.tuxgraphics.org
  Here you can get all the components needed to build this small web-server.
