Using Arduino for the smart management of electric appliances

Components that have been used for the construction of this prototype are the following:

- Arduino Uno;
- 74HC595 Shift register;
- 16x2 LCD display, which consists of:
    - one NPN transistor;
    - a trimmer;
- Photo resistor;
- Relay;
- 2x Pushbuttons;

Arduino sends data to be visualized on the LCD display to the shift register through the pins *INPUT (14), CLOCK (11)* and *REFRESH OUTPUT (12).* The shift register performs a translation from serial to parallel and sends data through four of the eight pins of the LCD display. Moreover, it uses one pin of the NPN transistor to securely control the backlight of the LCD display. The reader is invited to check Figure 2 for the schema of the LCD display. Pins directly used by the shift register to send data to the LCD display are: *RS, E, D4-D7,* and *K for controlling the backlight.* The shift register is not essential but it has been employed to reduce the number of pins directly used on the Arduino. Without it, the Arduino would have been connected directly to the LCD using eight pins (as mentioned above). After describing the procedure how the data are sent and shown on the LCD display, let us move on with the other components. Figure 3 shows the schema of the used shift register.

Figure 2. The 16x2 LCD display and its pins employed for the prototype.

The photo resistor is a light-controlled variable resistor. The resistance of a photoresistor decreases with increasing incident light intensity; in other words, it exhibits photoconductivity. It is connected to the analogic pin of Arduino with a push down resistor. Arduino reads through the pin connected to the photo resistor a value ranging from 0 to 1023, which indicates the intensity of the light in the environment. A value closer to 0 means absence of light whereas a value closer to 1023 indicates the highest intensity. A value between 600 and 800 indicates acceptable indoor light. Just to get an idea on real settings, solar light has a value closer to 950. A default value of 650 is used as threshold of the system. When the light has an intensity value smaller or equal than the threshold the system is activated, otherwise it is turned off.

Figure 3. 595 Shift register and its schema.

The two push buttons are connected in a pull down configuration to two interrupt pins of the Arduino board. They start two interrupt routines whose purpose is to increase or decrease the threshold value for the intensity of light that enables the system.
Finally, a 5V relay is connected to a digital pin of Arduino and it is enabled when the intensity of light is below the threshold. The relay is connected to a lamp or any other electric appliance having a power in compliance with that supported by the relay.
As far as the software is concerned, the LiquidCrystal595 Arduino Library has been employed for driving the LCD instead of the classic LiquidCrystal because of the presence of the Shift Register, this library also permit to manage the backlight of the LCD without any additional configuration.

Figure 4 shows the assembled prototype.

It is important to note that the schema presented in this subsection does not change at all if we replace the photo resistor with any other sensor (e.g. temperature, humidity, etc.) in order to control the electric appliance connected to the relay according to the temperature or humidity of the environment.

Figure 4. The assembled prototype.

SHIFT REGISTER CABLING:

1. Qb -> LCD pin D7
2. Qc -> LCD pin D6
3. Qd -> LCD pin D5
4. Qe -> LCD pin D4
5. Qf -> Not used
6. Qg -> NPN Transistor BASE
7. Qh -> LCD pin RS
8. GND
9. Qh' -> Not used
10. SRCLR -> Vcc
11. SRCLK (CLOCK) -> Arduino pin 9
12. RCLK (REFRESH OUTPUT) -> Arduino pin 8
13. OE -> GND
14. SER (INPUT) -> Arduino pin 7
15. Qa -> LCD pin E
16. Vcc

NPN TRANSISTOR CABLING

1. EMITTER -> GND
2. BASE -> SHIFT REGISTER pin 6
3. COLLECTOR -> LCD pin K

LCD CABLING:

1. GND
2. VCC
3. V0 -> Display contrast (Trimmer)
4. RS -> Shift Register pin 7
5. R/W -> GND
6. E -> Shift Register pin 15
7. D0 -> Not Used
8. D1 -> Not Used
9. D2 -> Not Used
10. D3 -> Not Used
11. D4 -> Shift Register pin 4
12. D5 -> Shift Register pin 3
13. D6 -> Shift Register pin 2
14. D7 -> Shift Register pin 1
15. A -> Vcc
16. K -> NPN COLLECTOR