REMOTE CONTROL LED WITH TIME/TEMPERATURE/DATE DISPLAYING LCD SCREEN AND TOUCH SENSOR

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Introduction:

Objective:

While most of the LEDs that we commonly used are being controlled by a single wired switch, sometimes when we are right about to fall asleep in our cozy bed, especially in the winter, we find it so tormenting to get up, reach the switches, and turn off the LEDs. A friendly designed wireless bedside system that controls all the LEDs around the house would avoid such cases.

Since some people might prefer other bedside functionalities as well, we propose to create a multi-functional user-friendly remote control LED system that has some designed features including:

1. LCD screen that displays the current time, room temperature and room humidity to the user.
2. Functioning alarm clock which rings at user's predefined time.
3. Capacitive touch switches that turn the LEDs on and off.
4. LEDs brightness level controlling through power MOSFETs.

Background:

Although some companies(Siemens[1], etc.) have been developing bedside displays(usually in the form of a digital clock plus radio), our design is significantly different from most of the existing designs, in a way that our system are targeted to switch the LEDs around the house and adjust their brightness. We are confident that if we can produce such bedside system with affordable parts, it will be a marketable product as one of the most powerful bedside systems.

High Level Requirements:

- The antenna design for large directivity antennas needs to be precise and accurate. It needs to obey FCC regulations.
- Choose from phase shift control and MOSFET control for LED brightness levels.
- Real-time wireless data transmission is required.
- PWM pulse width control (a microprocessor to receive command and generate PWM wave pulse) to drive MOSFET to control LED brightness, with 12 different brightness levels.
- Use an I2C data bus for data storage and reading.
- The screen should display time, humidity, and temperature while also functioning as an alarm clock.

Design:

1. The switch uses a capacitive touch sensor (such as TTP223B) to turn on and off.
2. A self-designed antenna (FM receiver) with transmitter side near capacitive touch sensor to send out turn-on and turn-off demand and receiver side near LED to follow demands.
3. Two LCD screens showing room temperature, time and date using Real-time clock DS3231 in both the transmitter side and the receiver side also make an alarm clock using the time shown from real-time clock DS3231.
4. AC adaptor for power supply. For this part I plan to use a rectifier as an AC to DC converter. It is called rectifier because it only strengthens current in one direction.
5. PWM pulse width control (a microprocessor to receive command and generate PWM wave pulse) to drive MOSFET to control LED brightness, with 12 different brightness levels. Every time we turn off the LED, it would automatically save the brightness level so the next time when we turn it on it would remain in the same brightness level.
6. Use an I2C data bus for data storage and reading. But we can still use a PCB for wire connection.
7. Wireless Data transmission section using two ATMEGA328P microprocessors and other Arduino components.

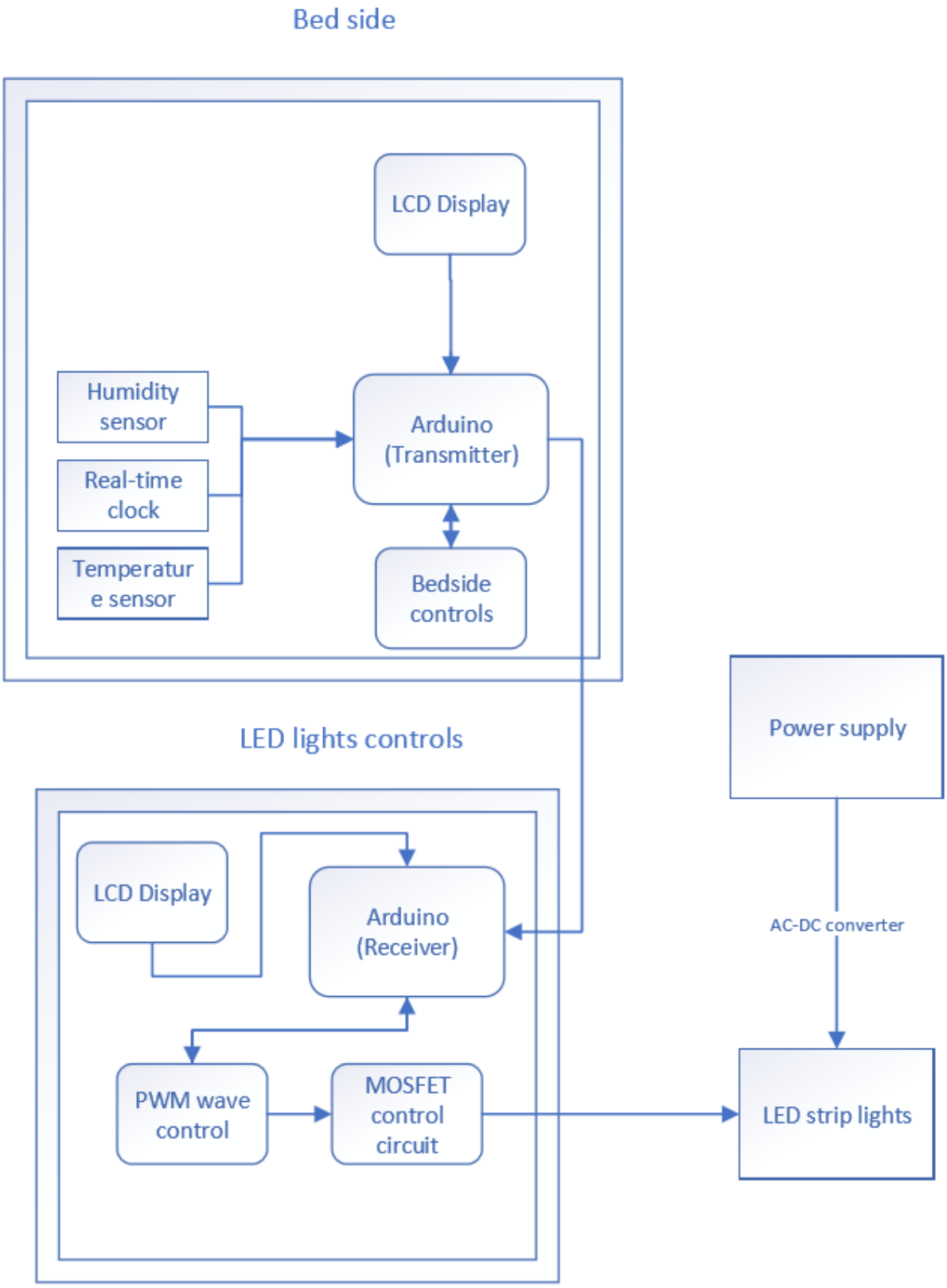

Figure 1: Block Diagram

Physical Design:

We split our designs into two parts, the bedside and the LEDs side. All the sensors are located on the bedside. Those sensors give us feedback on room humidity, room temperature and local time, along with the capacitive touch switch which gives us information on whether the LEDs are on or off. If the user turn the capacitive touch switch on, then the arduino on the bedside will send a turn-on message to the the arduino on the LED side, which, after receiving the signal, gives commands to PWM wave control and further controls the MOSFET block for LEDs brightness. Finally, the MOSFET block decides with the brightness level in which LEDs will be turned on.

Power Subsystem:

We will use a standard AC to DC converter to transfer AC circuit provided at houses to DC circuit needed for LED circuit.
A current regulator that ensures the circuit current does not go too high and cause some potential danger.

Sensor Subsystem:

1. Humidity sensor that gives out in-room humidity information to be put in two LCD screens.
2. LM35 Series Board Mount Temperature Sensor[2] that shows real-time temperature to be put in two LCD screens. The accuracy is +/- 2 C
3. DS3231 Maxim Integrated Real Time Clock[3] that gives very accurate time information to be indicated in two LCD screens.
4. Catalex TTP223B Arduino Capacitive Touch Sensor[4] which decides whether or not to turn on the LED. This is the most important sensor in all these four sensors.

Central Control Subsystem:

We use two arduinos, or ATMega328P micro-processor chips[5] for data and command position and orientation. Since ATMega328P chips are central units for Arduino, we should be able to write code to decide their behaviors just as we did in other classes involving the use of arduino. For brightness control we use L7805CV[6] electronic part distributor along with two IRF540p power MOSFET and a BD139 NPN bipolar- junction transistor, two 100 kohm resistors, four 10 kohm resistors, one 500 ohm resistor, two 0.1 uF capacitor and 5V, 12V voltage supply.

The brightness control circuit looks like follows:

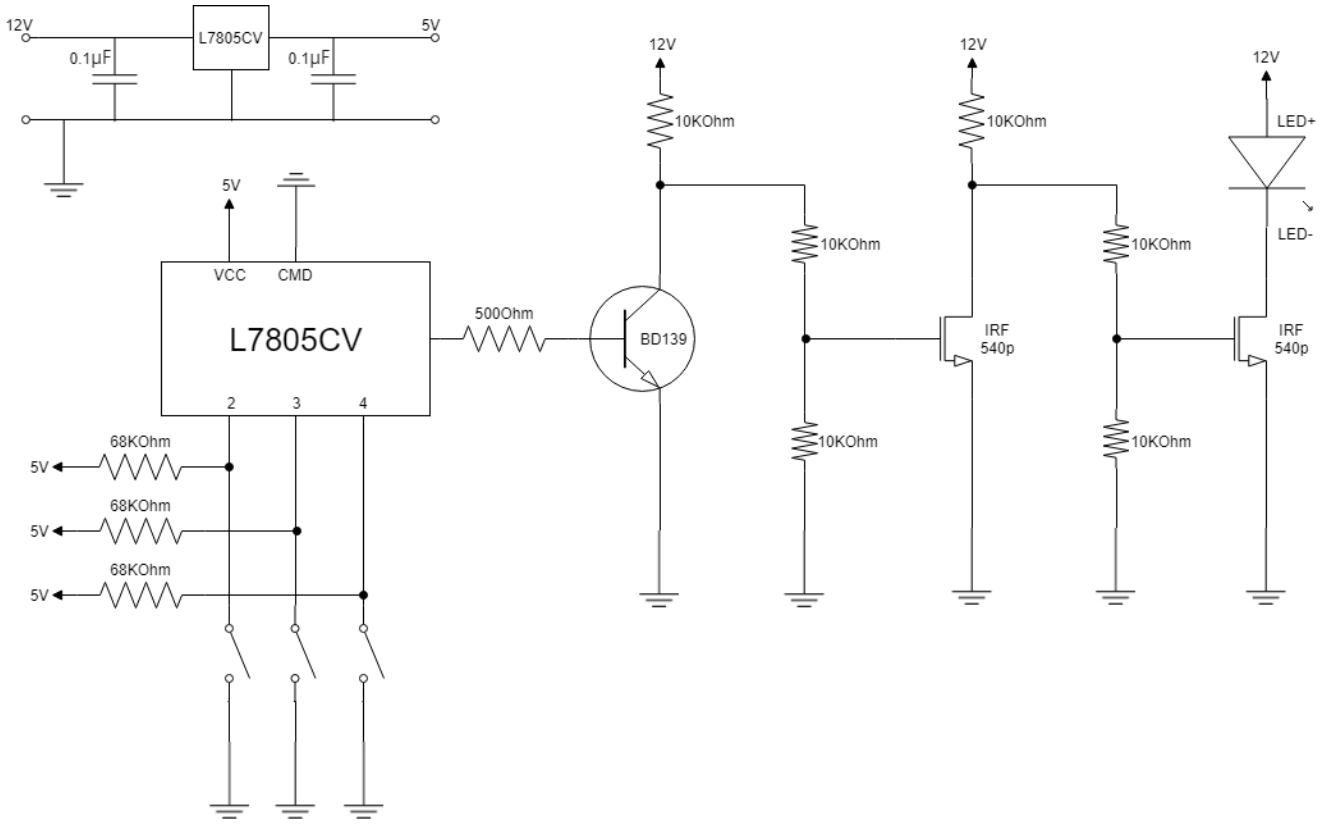

Figure 2: Brightness Control Circuit

Risk Analysis:

All the parts are important to make a successful project with all our expected functions of it working well. However, one of the most important part to achieve this goal is the inter-reaction between two ATMega328P chips. They are the central control unit for all the other controls and they connect the information given from four sensors to the displayed information on LCD screens. They also help to generate PWM wave control signal for LED brightness control. There might be some other issues such as the voltage might go too high that LEDs cannot bear, leading to some potential burning-ups. So we need a voltage regulator for the power supply part because LEDs are fragile electronic devices.

Safety and Ethics:

There are two main safety concerns that we are aware of and should pay attention to. First, when soldering, always remember to solder + and - sides of LED strip to + and - ends of power supply correctly, else ATMEga328P chip on the receiver side might be burned. For the LEDs connection, even if the + and - sides are connected correctly, we still need voltage regulators in case of sudden rise of voltage provided to LED strips leading to LED burning-ups.

We will also take the IEEE Code of Ethics[7] as our basic code of ethics. More specifically, our product should not be used as a part for a weapon, or as a platform to perform illegal surveillance, which violate the code 9 of the IEEE Code of Ethics. We will keep our parts and codes private from the public so that only autorized people can access them. During the process of development, all the parts should be keep in dry and safe place, and should be handled with care to avoid hazardous condtions. We will follow the code 3 of the IEEE Code of Ethics and always be honest and realistic when building our project and reporting our status.

References:

1. *Mid Century 1970's Orange Radio Alarm clock Siemens Alpha - Digital Alarm Clock.*
   URL: https://www.etsy.com/listing/695360056/mid-century-1970s-orange-radio-alarm

2. *LM35 ± 0.5C Temperature Sensor with Analog Output and 30V Capability.*
   URL: http://www.ti.com/product/LM35

3. *DS3231 Extremely Accurate I^2C-Integrated RTC/TCXO/Crystal.*
   URL: https://www.maximintegrated.com/en/products/analog/real-time-clocks/DS3231.html

4. *TTP223 Capacitive Touch Switch Circuit.*
   URL: https://www.electroschematics.com/11865/ttp223-capacitive-touch-switch-circuit/

5. *ATmega328P - 8-bit AVR Microcontrollers.*
   URL: https://www.microchip.com/wwwproducts/en/ATmega328p

6. *L7805CV STMicroelectronics.*
   URL: https://www.digikey.com/product-detail/en/stmicroelectronics/L7805CV/497-1443-5-ND/585964

7. *IEEE Policies, Section 7 - Professional Activities (Part A - IEEE Policies) - 7.8 IEEE Code of Ethics.*
   URL: https://www.ieee.org/about/corporate/governance/p7-8.html