ELEC327 Final Project Report
Smart Lamp

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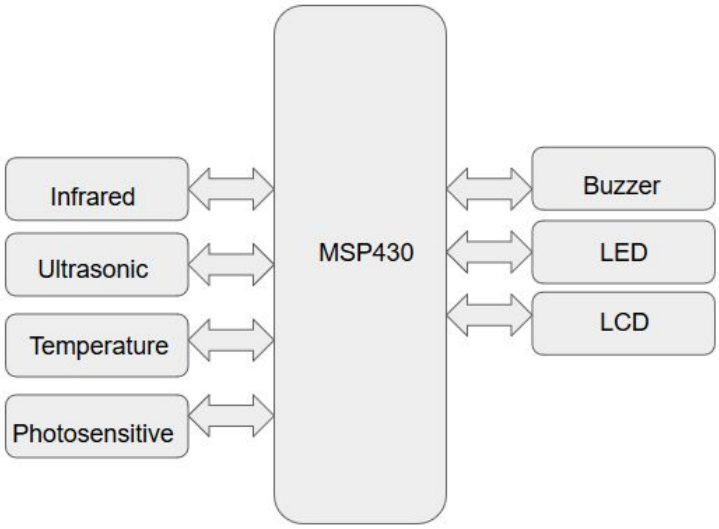
1. Introduction: Inspiration & Ideas

People need lamps in almost all kinds of places: offices, classrooms, labs etc. Lamps enable us to work comfortably, and a good lamp can make a person work even more efficiently. As technology develops, lamps are not only limited to lightning tools: many lamps have more complex functions like charging, digital display, etc., and as lamps become multifunctional, they can help with people's work even more. Therefore, inspired by this idea and trend, we decided to develop a smart lamp with MSP430 and various sensors: apart from lightning, our lamp is able to read the room temperature and report to the user through an LCD screen, and can light up/ turn off automatically by using an infrared motion detector to detect whether there is anyone around. If there is no one around for a short period of time, the LED lamp will turn off automatically. In this way, users can know various specs about the room by looking at the LCD screen on the lamp, and the automatic on/off function helps to prevent energy waste if the user forgot to turn off the lamp and saves people from manually pushing the switch. Moreover, our project has a photosensitive module which can detect the environmental light intensity. When the environment gets dark enough, the LED will turn on automatically. Lastly, our project can further be used as a reading lamp which can protect user's vision because the ultrasonic module can tell the distance between the person and the lamp. If the person gets too close to the lamp (<30cm), the buzzer will be triggered. If the distance is smaller than 10 cm for a period of time, the lamp will turn off to protect user's vision.

2. Design:

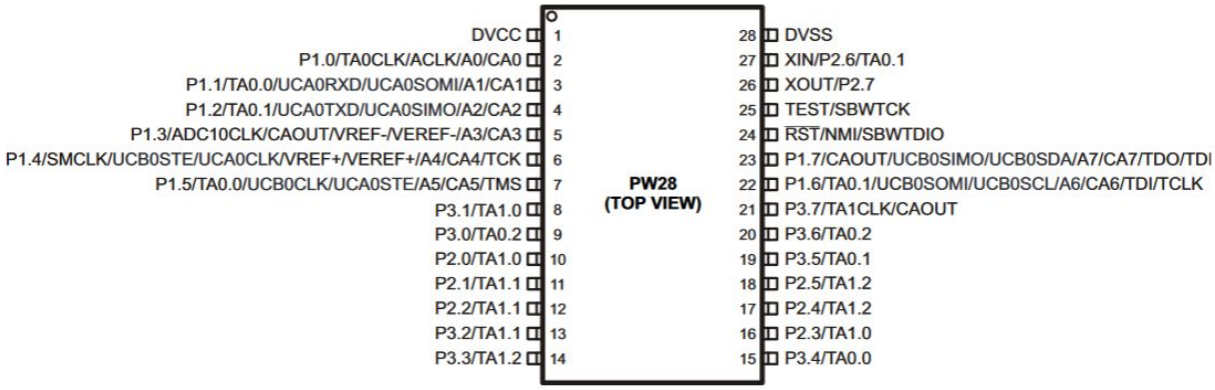
2.1 Block diagram for the whole project



2.2 Parts Listed:

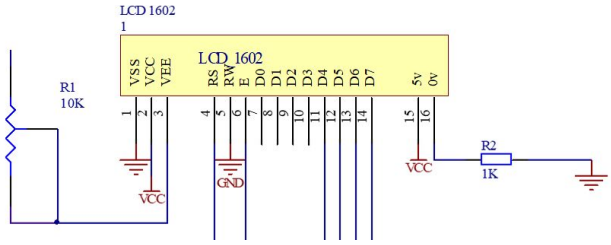
2.2.0. MSP430G2553

This is the exact same microcontroller we had been playing with all semester. MSP430G2553 is an ultra-low-power mixed signal microcontrollers with built-in 16-bit timers, up to 24 I/O capacitive-touch enabled pins, a versatile analog comparator, built-in communication capability using the universal serial communication interface, and a 10-bit analog-to-digital (A/D) converter.



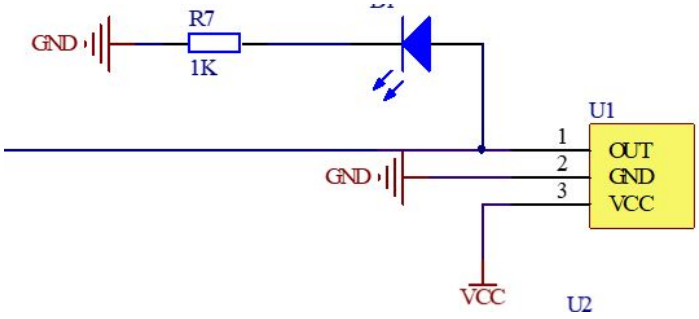
2.2.1. LCD1602 Liquid Crystal Display

As shown in the picture above, LCD1602, or 1602 character-type liquid crystal display, is a kind of dot matrix module to show letters, numbers, and characters and so on. (See the picture on the left). The model 1602 means it displays 2 lines of 16 characters. We used this to display information to the user, like temperature, distance etc. (See the picture on the right). Right now the temperature is 22.1 degrees Celsius and the distance between the user and the ultrasonic module is 12cm. The schematic for LCD1602 is shown below:



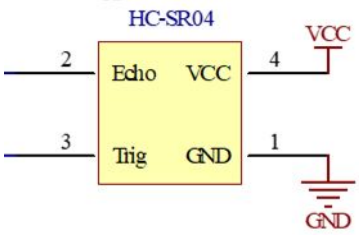
2.2.2. Infrared Motion Detector HC_SR501

As shown above, HC_SR501 is a PIR sensor (Passive infrared sensor) that can be used to detect warm bodies. When the sensor is idle, the two halves of the sensor senses the same amount of infrared radiation, resulting in a zero output signal.When a warm body like a human passes by/ leaves the sensing area , positive/ negative differential change will occur between the two halves of the sensor, thus creating a pulse output signal that we could use. In this way, we could let the microcontroller if there is a user nearby and thus get the lamp ready. The schematic is shown below:

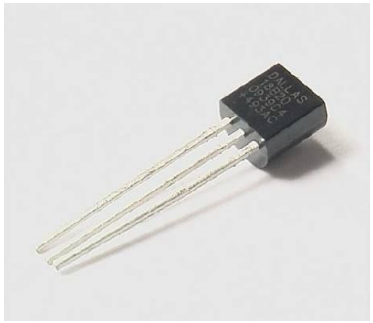


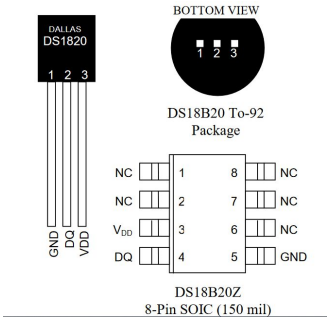
2.2.3. Ultrasonic Ranging Module HC_SR04

This sensor provides 2cm to 400cm of non-contact measurement functionality with a ranging accuracy that can reach up to 3mm. The sensor is able to calculate the distance by measuring the time difference between a wave generated and received. In our project, we are able to know how far the person is from the lamp with the help of this sensor, and accordingly display this information on the LCD screen. If the person is too close, the microcontroller will trigger the alarm and warn the user. The schematic is shown below:

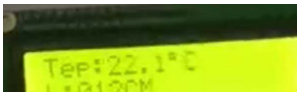


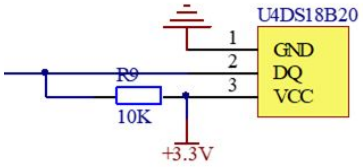
2.2.4. Temperature Sensor DS18B20





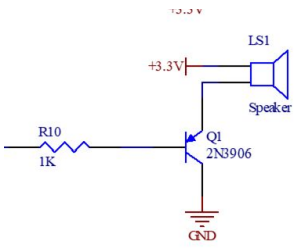
This sensor will read the room temperature and display it on the LCD screen. See below, the room temperature is 22.1 celsius degree. It has unique 1-Wire interface which requires only one port pin for communication.

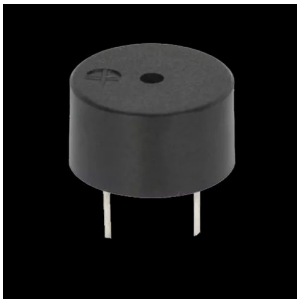




2.2.5. Buzzer

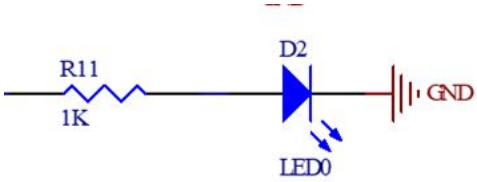
The speaker we used are the same one as we used in lab7. MSP will make the speaker make sounds to warn the user if the distance is too close.





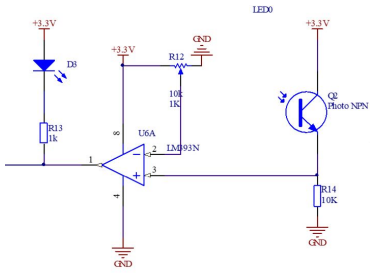
2.2.6. LED

The LED serves as the lightning section of the lamp. We used a 5mm high-brightness white LED, see below. We plan to replace this LED with better ones in future development.



2.2.7. Photosensitive Module

The photosensitive module can detect the light intensity in the environment. The LED will turn on only when the environment is dark enough. When the environment is bright enough, the LED will turn off in order to save energy. The schematic for photosensitive module is shown below:



3. Code

See main.c in the our Git project.
Website: https://github.com/shuaichengli0428/elec327-final-project-smart-lamp

4. Results and Discussions

4.1 Challenges

We ordered these parts online. The ultrasonic ranging module was broken during transportation. We had to use expedited shipping to get a new one due to limited days.

One tiny section of the PCB board was shorted, causing the nearby circuits to fail. We used an oscilloscope to test the board and found out this error. We manually broke the shorted wire apart and the board was good.

4.2 Future Work

In our design, once the lamp detected that there is a user nearby and lights up, the brightness of the lamp light is fixed. In future experiments, we plan to use PWM to adjust the brightness of LED, relevant to the distance between this product and the user. The closer the user is, the dimmer the lamp will be in order to protect the user's vision.

Also, the LED we used in this experiment is not bright enough. In real world circumstances, we definitely need a brighter LED/ light bulb. Since the power of the new light might be way higher than now, a new power circuit could be build and components like power amplifiers could be used.