**Making Embedded Systems**

**by Elecia White**

**Final Project Report: Remote Controller for UVC LED LIGHTS**

# **Introduction**

I’m not exactly sure what to call this project, I will try to explain the application and hopefully this should clarify the project design as well as the feature associated with the project. The project idea came as a result of the SARS-CoV-2 pandemic. Much earlier at the beginning of the pandemic there were a lot of information regarding virus transmission by surface contacts. There were also varying information on how long the virus could survived on surfaces. Me being a curious person by nature, I felt compelled to research existing approach for surface decontamination. One approach that stood out to me was using UV light as a way to destroy viruses on surfaces. I then proceeded to check amazon for existing products and there were plenty of options available. I still felt the need to design my own system with specific feature in mind, because of course I can make it much better!

**Project Features:**

* Local and Remote system.
* Local and Remote system should communicate wirelessly.
* Local system feature:
  + Button to arm the remote system.
  + Status indication to that system is arm.
  + Need to be mountable on a door.
  + Need a sensor to detect when the door is open when system is armed.
  + Need to be flexible so can be moved to different room.
  + Battery power to allow flexibility of movement.
* Remote system features:
  + Power over USB with a 5V adapter.
  + Need an IO to control UVC lights.
  + Need to listen to Local system for incoming commands.
  + Needs to disarm the system if communication with local system is lost.

**Rationale for chosen features:**

UV light specifically UV-C light occupying the wavelength of 200 to 280 nm is very effective at destroying pathogens and also unfortunately can cause skin and eye damages to both human and pets. Due to this reason I had to choose some feature that would allow me to turn on the Light remotely, as well as prevent accidental exposure to the lights for pets and human being.

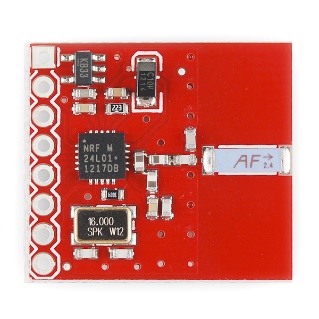
# **Part Selection**

To accomplish he project feature the following parts were selected:

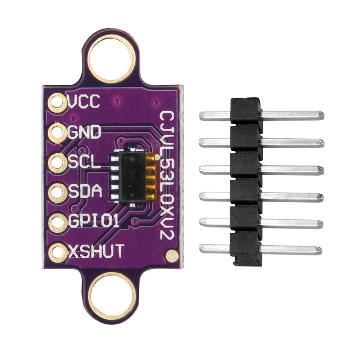
1. nRF24L01+ Transceiver breakout board from spark fun.

Features:

* Operation band: 2.4GHZ ISM band
* Speed: 250kbs,1Mbs,2Mbs on air rate
* 126 RF channels
* SPI interface
* Electrical rating:
  + 11.3mA TX on 0dBm output power, 13.5mA RX at 2Mbs air data rate.
  + 900nA in power down
  + 26uA in standby-1
  + 1.9 to 3.6V supply range

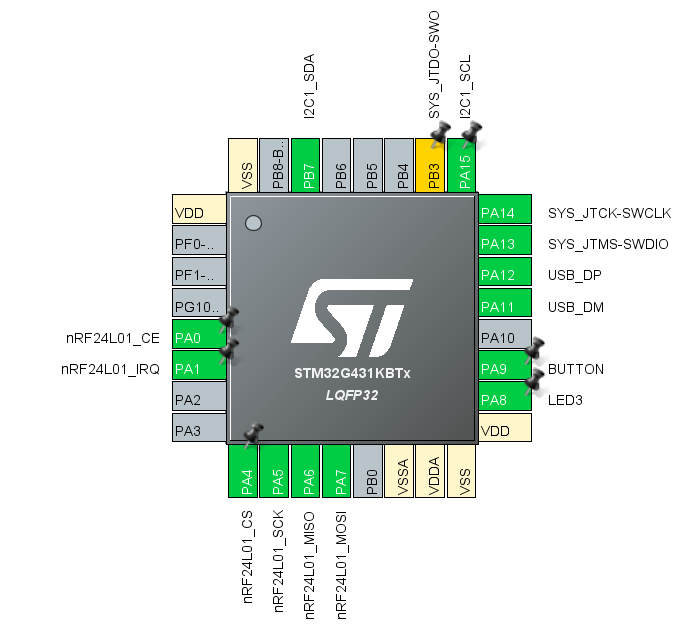


1. VLX53L0X Time of Flight(ToF) sensor:
   * Measure ranges up to 2m
   * Class 1 laser device
   * I2C interface
   * Programable I2C address
   * Electrical rating:
     + 2.6 to 3.5 V supply range
     + 19mA active range average consumption
     + HW standby 3 – 7 uA, typical 5uA, SW standby 4 – 9 uA, typical 6uA



1. STM32G431KBT6 microcontroller:

* Core: Arm® 32-bit Cortex®-M4 CPU with FPU, Adaptive real-time accelerator (ART Accelerator) allowing 0-wait-state execution from Flash memory, frequency up to 170 MHz with 213 DMIPS, MPU, DSP instructions
* 128 Kbytes of Flash
* 32 KB SRAM
* USB 2.0 full-speed interface with LPM and BCD support
* 3 x SPIs, 4 to 16 programmable bit frames,
* 3 x I2C Fast mode plus (1 Mbit/s) with 20 mA current sink
* 1 x LPUART
* 4 x USART/UARTs (ISO 7816 interface, LIN, IrDA, modem control)
* Single precision FPU
* Electrical rating: VDD, VDDA voltage range: 1.71 V to 3.6 V



# Hardware Design Diagram

Shown below is the hardware design block diagram showing how each module interface with the Microcontroller (MCU).

On the local system, the user interacts with the local system using the ARM Button and ARM LED Status through GPIO. To arm or disarm the system, the MCU sends commands over SPI to the NRF24L01 transceiver. Once the system is armed, the VLX530X TOF system is used to detect when the door is open through I2C. For debugging on the local system, the USB interface is used to communicate with a computer using the USB CDC class.

On the remote system, the MCU monitor for commands coming from the local system through the NRF24L01 through SPI. The MCU then enable or disable Light through an output GPIO. For debugging purpose, the UART is used to communicate with the PC through the ST link debugger on the Nucleo-g431kb board running as the Remote system.

