ECE561 **Project 4**

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Following changes were made to the program to achieve the desired power optimization.

1. Low leakage stop mode was enabled.
2. Low power timer was used to wake up MCU from sleep
3. The frequency variable for LpTmr was altered from 500 to2.
4. During the phase where yellow LED was to be lit green and red LED's where used separately to create the effect of yellow
5. Execution time was optimized using level-3 time optimization
6. I2C communication was made to run at its fastest speed
7. Also changes were made to achieve floating point math operation and few calculations like 180/PI were replaced by numerical value.
8. Delays were used to turn off LED and the value of delay function was modified.
9. To further save power startup yellow LED was removed.
10. For Yellow and Green LED width modulation was achieved using a variable which alters the timing of LED glow. This variable was incremented per cycle and was used as time measuring tool. By experiment it was found that for 38 increments, time was 20 seconds.

    With the above changes implemented, the system was able to run for 8 minutes with following testing method

TESTING PROCESS

1. Discharge ultracap by shorting its leads for at least one minute.
2. Power Freedom board by connecting USB cable.
3. Connect shorting jumper on J20 so P3V3 rail is at 3.3 V.
4. Connect ultracap to J9 pins 8 and 12 to charge it at 3.3 V for 30 seconds.
5. Disconnect ultracap from J9 and allow to float for ½ minute until voltage stabilizes. Measure this voltage and use it for your starting point in energy calculations (e.g. 2.760 V @ 30 sec, 2.750 V @ 60 seconds, 2.743 V @ 90 seconds)
6. Remove power from Freedom board by disconnecting USB cable.
7. Remove shorting jumper from J20 so P3V3 rail does not drive voltage regulator.
8. Connect ultracap to J9 pins 8 and 12 and measure run time of system.
9. Tilt profile during testing
    a. First 20 seconds of each minute: <15 degrees, green
    b. Second 20 seconds of each minute: >15 and <30 degrees, yellow
    c. Third 20 seconds of each minute: >30 degrees, red

For final run the change in voltage was 2.773V(@30) to 2.198V for 480sec

$$E = \frac{V1^2 - V2^2}{2} C \ = 0.31J$$

$$P = \frac{V1^2 - V2^2}{2t} C \ = 0.000658J$$

Initially with the base code the system was able to run only for just 7 seconds. With Low leakage stop activated and Lptmr the controller was put to sleep for a considerable amount of time that helped reducing the power consumption. As the frequency variable of Lptmr timer was altered the amount of sleep time for controller increased. Further, LED were turned off after a certain delay. With these changes and enabling Time optimization an execution of around 5 mins & 10 sec was achieved. Next the on time of LED for Green, red and yellow was optimized in order to ensure moderate light intensity at the beginning and then the width of delay was increased per minute as the intensity faded with increasing time and

decreasing voltage. With these changes system was able to run for around 8 mins and the desired result was attained.