Lab(BOARD LIBRARY UPDATE)

ESE 3025: EmbeddedReal Time Operating Systems

Lambton College in Toronto

Instructor: Takis Zourntos

STUDENT NAME & ID:

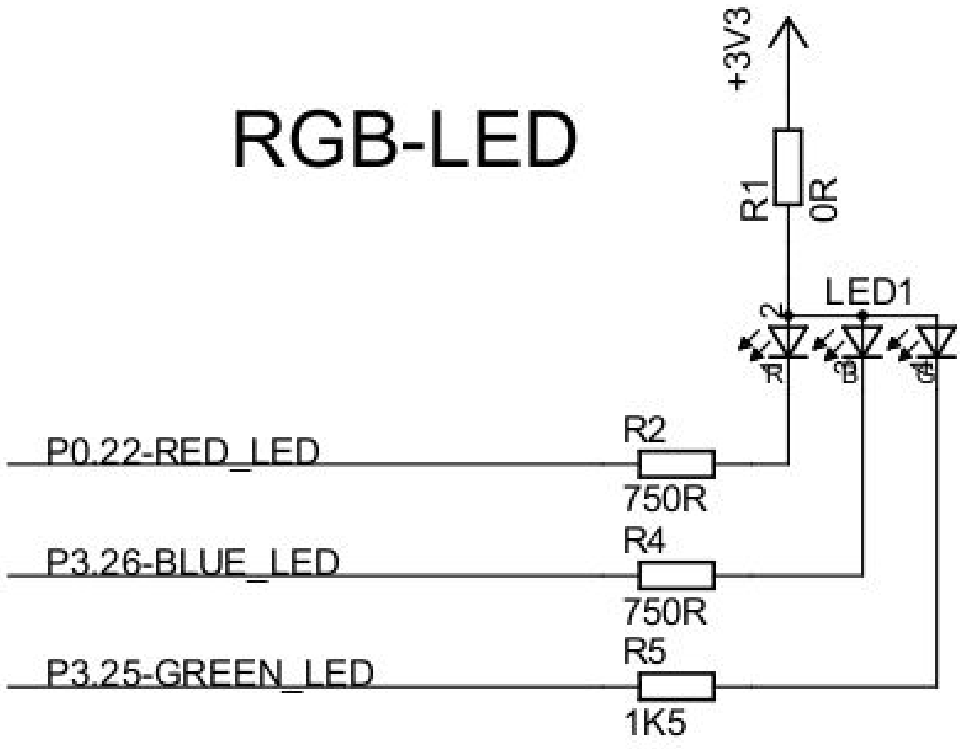
Vishal Hasrajani(C0761544)
Parth Patel(C0764929)
Goutham Reddy Alugubelly(C0747981)
Ratnajahnavi rebbapragada(C0762196)

INTRODUCTION :

The default board library of the LPC 1769 is not updated properly in order to access the onboard LEDS in MCUXpresso IDE. So in this LAB we will make proper modifications in order to access the onboard led of lpc 1769.

DESCRIPTION :

To begin with,we have to go through LPC 1769 user manual to get the clear idea of the port and pin number of the onboard LEDs.



Updates that we made in the **board.c** are as follows.

RED led is at port 0 and bit number is 22.
GREEN led is at port 3 and bit number is 25.
BLUE led is at port 3 and bit number is 26.

(1)

```
#define LED_RED_GPIO_PORT_NUM                         0
#define LED_RED_GPIO_BIT_NUM                          22
#define LED_GREEN_GPIO_PORT_NUM                        3
#define LED_GREEN_GPIO_BIT_NUM                        25
#define LED_BLUE_GPIO_PORT_NUM                         3
#define LED_BLUE_GPIO_BIT_NUM                         26
```

(2)The function **Board_LED_Init** is used to set the selected GPIO port as output.

```
static void Board_LED_Init(void)
{
/* Pin PIO0_22 is configured as GPIO pin during SystemInit
*/
/* Set the PIO_22 as output */
//LPC_GPIO is the base of the GPIO peripheral on the chip.
//LED_RED_GPIO_PORT_NUM is the port 0
//LED_RED_GPIO_BIT_NUM is the bit number of RED led.(i.e
22)
// true means GPIO is set to the output.
Chip_GPIO_WriteDirBit(LPC_GPIO, LED_RED_GPIO_PORT_NUM,
LED_RED_GPIO_BIT_NUM, true);
//Similarly for Green led
Chip_GPIO_WriteDirBit(LPC_GPIO, LED_GREEN_GPIO_PORT_NUM,
LED_GREEN_GPIO_BIT_NUM, true);
//Similarly for Blue led
Chip_GPIO_WriteDirBit(LPC_GPIO, LED_BLUE_GPIO_PORT_NUM,
LED_BLUE_GPIO_BIT_NUM, true);
}
```

(3)
The function **Board_LED_Set** is used to set the state of the board LED to on or off.

```

void Board_LED_Set(LED_colour_t LED, bool On)
{
     bool state =!On; // not really ,turn the lED on or off
     /* There is only one LED */
     if (LED == red) {
          Chip_GPIO_WritePortBit(LPC_GPIO,
LED_RED_GPIO_PORT_NUM, LED_RED_GPIO_BIT_NUM, state);
     }
     else if (LED == green)
     {
          Chip_GPIO_WritePortBit(LPC_GPIO,
LED_GREEN_GPIO_PORT_NUM, LED_GREEN_GPIO_BIT_NUM, state);
     }
     else if (LED ==blue)
     {
          Chip_GPIO_WritePortBit(LPC_GPIO,
LED_BLUE_GPIO_PORT_NUM, LED_BLUE_GPIO_BIT_NUM, state);
     }
}
```

(4)
This function **board_LED_Test** returns the current state of the LED

```
bool Board_LED_Test(LED_colour_t LED)
{
     bool state = false; //default setting up state=0
//Checking state for RED
     if (LED == red) {
          state = Chip_GPIO_ReadPortBit(LPC_GPIO,
LED_RED_GPIO_PORT_NUM, LED_RED_GPIO_BIT_NUM);
     }
//Checking state for GREEN
     else if (LED == green)
     {
          state = Chip_GPIO_ReadPortBit(LPC_GPIO,
LED_GREEN_GPIO_PORT_NUM, LED_GREEN_GPIO_BIT_NUM);
     }
//Checking state for BLUE
     else if (LED == blue)
          {
               state = Chip_GPIO_ReadPortBit(LPC_GPIO,
LED_BLUE_GPIO_PORT_NUM, LED_BLUE_GPIO_BIT_NUM);
          }

     return state; //Returning the state whether its on or
off.
}
```

(5)
The function **Board_LED_Toggle** is used to toggle the LED that is selected by the user.

```
void Board_LED_Toggle(LED_colour_t LED)
{
     if (LED == red) {
          Board_LED_Set(LED, !Board_LED_Test(LED));
     }
     else if (LED == green) {
               Board_LED_Set(LED, !Board_LED_Test(LED));
          }
     else if (LED == blue) {
                    Board_LED_Set(LED,
!Board_LED_Test(LED));
               }
}
```

(6)In **board.h** we have added LED color using typedef

```
typedef enum
{
     red,green,blue
}LED_colour_t;
```

CONCLUSION :

To conclude,we made all the possible changes in **board.c** to access the onboard LED of the LPC 1769 Embedded Platform.

APPENDIX:

```
/*
 * @brief NXP LPC1769 LPCXpresso board file
 *
 * @note
 * Copyright(C) NXP Semiconductors, 2012
 * All rights reserved.
 *
 * @par
 * Software that is described herein is for illustrative
purposes only
 * which provides customers with programming information
regarding the
 * LPC products.  This software is supplied "AS IS" without
any warranties of
 * any kind, and NXP Semiconductors and its licensor
disclaim any and
 * all warranties, express or implied, including all
implied warranties of
 * merchantability, fitness for a particular purpose and
non-infringement of
 * intellectual property rights.  NXP Semiconductors
assumes no responsibility
```

```
 * or liability for the use of the software, conveys no
license or rights under any
 * patent, copyright, mask work right, or any other
intellectual property rights in
 * or to any products. NXP Semiconductors reserves the
right to make changes
 * in the software without notification. NXP Semiconductors
also makes no
 * representation or warranty that such application will be
suitable for the
 * specified use without further testing or modification.
 *
 * @par
 * Permission to use, copy, modify, and distribute this
software and its
 * documentation is hereby granted, under NXP
Semiconductors' and its
 * licensor's relevant copyrights in the software, without
fee, provided that it
 * is used in conjunction with NXP Semiconductors
microcontrollers.  This
 * copyright, permission, and disclaimer notice must appear
in all copies of
 * this code.
 */

#include "board.h"
#include "string.h"

#include "retarget.h"

/***********************************************************
*****************
```

```
 * Private types/enumerations/variables

************************************************************
*****************/
#define BUTTONS_BUTTON1_GPIO_PORT_NUM           2
#define BUTTONS_BUTTON1_GPIO_BIT_NUM            10
#define JOYSTICK_UP_GPIO_PORT_NUM               2
#define JOYSTICK_UP_GPIO_BIT_NUM                3
#define JOYSTICK_DOWN_GPIO_PORT_NUM             0
#define JOYSTICK_DOWN_GPIO_BIT_NUM              15
#define JOYSTICK_LEFT_GPIO_PORT_NUM             2
#define JOYSTICK_LEFT_GPIO_BIT_NUM              4
#define JOYSTICK_RIGHT_GPIO_PORT_NUM            0
#define JOYSTICK_RIGHT_GPIO_BIT_NUM             16
#define JOYSTICK_PRESS_GPIO_PORT_NUM            0
#define JOYSTICK_PRESS_GPIO_BIT_NUM             17
#define LED_RED_GPIO_PORT_NUM                   0
#define LED_RED_GPIO_BIT_NUM                    22
#define LED_GREEN_GPIO_PORT_NUM                 3
#define LED_GREEN_GPIO_BIT_NUM                  25
#define LED_BLUE_GPIO_PORT_NUM                  3
#define LED_BLUE_GPIO_BIT_NUM                   26

/***********************************************************
*******************
 * Public types/enumerations/variables

************************************************************
*****************/

/* System oscillator rate and RTC oscillator rate */
const uint32_t OscRateIn = 12000000;
const uint32_t RTCOscRateIn = 32768;
```

```
/***********************************************************
*******************
 * Private functions

************************************************************
*****************/

/* Initializes board LED(s) */
static void Board_LED_Init(void)
{
     /* Pin PIO0_22 is configured as GPIO pin during
SystemInit */
     /* Set the PIO_22 as output */
     Chip_GPIO_WriteDirBit(LPC_GPIO, LED_RED_GPIO_PORT_NUM,
LED_RED_GPIO_BIT_NUM, true);
     Chip_GPIO_WriteDirBit(LPC_GPIO,
LED_GREEN_GPIO_PORT_NUM, LED_GREEN_GPIO_BIT_NUM, true);
     Chip_GPIO_WriteDirBit(LPC_GPIO,
LED_BLUE_GPIO_PORT_NUM, LED_BLUE_GPIO_BIT_NUM, true);
}

/***********************************************************
*******************
 * Public functions

************************************************************
*****************/

/* Initialize UART pins */
void Board_UART_Init(LPC_USART_T *pUART)
{
     /* Pin Muxing has already been done during SystemInit
```

```
*/
}

/* Initialize debug output via UART for board */
void Board_Debug_Init(void)
{
#if defined(DEBUG_ENABLE)
     Board_UART_Init(DEBUG_UART);

     Chip_UART_Init(DEBUG_UART);
     Chip_UART_SetBaud(DEBUG_UART, 115200);
     Chip_UART_ConfigData(DEBUG_UART, UART_LCR_WLEN8 |
UART_LCR_SBS_1BIT | UART_LCR_PARITY_DIS);

     /* Enable UART Transmit */
     Chip_UART_TXEnable(DEBUG_UART);
#endif
}

/* Sends a character on the UART */
void Board_UARTPutChar(char ch)
{
#if defined(DEBUG_ENABLE)
     while ((Chip_UART_ReadLineStatus(DEBUG_UART) &
UART_LSR_THRE) == 0) {}
     Chip_UART_SendByte(DEBUG_UART, (uint8_t) ch);
#endif
}

/* Gets a character from the UART, returns EOF if no
character is ready */
int Board_UARTGetChar(void)
{
```

```
#if defined(DEBUG_ENABLE)
     if (Chip_UART_ReadLineStatus(DEBUG_UART) &
UART_LSR_RDR) {
          return (int) Chip_UART_ReadByte(DEBUG_UART);
     }
#endif
     return EOF;
}

/* Outputs a string on the debug UART */
void Board_UARTPutSTR(char *str)
{
#if defined(DEBUG_ENABLE)
     while (*str != '\0') {
          Board_UARTPutChar(*str++);
     }
#endif
}

/* Sets the state of a board LED to on or off */
void Board_LED_Set(LED_colour_t LED, bool On)
{
     bool state =!On; // no ,turn the lED on or off
     /* There is only one LED */
     if (LED == red) {
          Chip_GPIO_WritePortBit(LPC_GPIO,
LED_RED_GPIO_PORT_NUM, LED_RED_GPIO_BIT_NUM, state);
     }
     else if (LED == green)
     {
          Chip_GPIO_WritePortBit(LPC_GPIO,
LED_GREEN_GPIO_PORT_NUM, LED_GREEN_GPIO_BIT_NUM, state);
     }
     else if (LED ==blue)
     {
          Chip_GPIO_WritePortBit(LPC_GPIO,
LED_BLUE_GPIO_PORT_NUM, LED_BLUE_GPIO_BIT_NUM, state);
     }
}

/* Returns the current state of a board LED */
bool Board_LED_Test(LED_colour_t LED)
{
     bool state = false;

     if (LED == red) {
          state = Chip_GPIO_ReadPortBit(LPC_GPIO,
LED_RED_GPIO_PORT_NUM, LED_RED_GPIO_BIT_NUM);
     }
     else if (LED == green)
     {
          state = Chip_GPIO_ReadPortBit(LPC_GPIO,
LED_GREEN_GPIO_PORT_NUM, LED_GREEN_GPIO_BIT_NUM);
     }

     else if (LED == blue)
          {
               state = Chip_GPIO_ReadPortBit(LPC_GPIO,
LED_BLUE_GPIO_PORT_NUM, LED_BLUE_GPIO_BIT_NUM);
          }

     return state;
}

void Board_LED_Toggle(LED_colour_t LED)
{
     if (LED == red) {
          Board_LED_Set(LED, !Board_LED_Test(LED));
     }
     else if (LED == green) {
               Board_LED_Set(LED, !Board_LED_Test(LED));
          }
     else if (LED == blue) {
                    Board_LED_Set(LED,
!Board_LED_Test(LED));
               }
}

/* Set up and initialize all required blocks and functions
related to the
   board hardware */
void Board_Init(void)
{
     /* Sets up DEBUG UART */
     DEBUGINIT();

     /* Initializes GPIO */
     Chip_GPIO_Init(LPC_GPIO);
     Chip_IOCON_Init(LPC_IOCON);

     /* Initialize LEDs */
     Board_LED_Init();
}

/* Returns the MAC address assigned to this board */
void Board_ENET_GetMacADDR(uint8_t *mcaddr)
{
     const uint8_t boardmac[] = {0x00, 0x60, 0x37, 0x12,
0x34, 0x56};
```

```
	memcpy(mcaddr, boardmac, 6);
}

/* Initialize pin muxing for SSP interface */
void Board_SSP_Init(LPC_SSP_T *pSSP)
{
	if (pSSP == LPC_SSP1) {
		/* Set up clock and muxing for SSP1 interface */
		/*
		 * Initialize SSP0 pins connect
		 * P0.7: SCK
		 * P0.6: SSEL
		 * P0.8: MISO
		 * P0.9: MOSI
		 */
		Chip_IOCON_PinMux(LPC_IOCON, 0, 7,
IOCON_MODE_INACT, IOCON_FUNC2);
		Chip_IOCON_PinMux(LPC_IOCON, 0, 6,
IOCON_MODE_INACT, IOCON_FUNC2);
		Chip_IOCON_PinMux(LPC_IOCON, 0, 8,
IOCON_MODE_INACT, IOCON_FUNC2);
		Chip_IOCON_PinMux(LPC_IOCON, 0, 9,
IOCON_MODE_INACT, IOCON_FUNC2);
	}
	else {
		/* Set up clock and muxing for SSP0 interface */
		/*
		 * Initialize SSP0 pins connect
		 * P0.15: SCK
		 * P0.16: SSEL
		 * P0.17: MISO
		 * P0.18: MOSI
```

```
          */
         Chip_IOCON_PinMux(LPC_IOCON, 0, 15,
IOCON_MODE_INACT, IOCON_FUNC2);
         Chip_IOCON_PinMux(LPC_IOCON, 0, 16,
IOCON_MODE_INACT, IOCON_FUNC2);
         Chip_IOCON_PinMux(LPC_IOCON, 0, 17,
IOCON_MODE_INACT, IOCON_FUNC2);
         Chip_IOCON_PinMux(LPC_IOCON, 0, 18,
IOCON_MODE_INACT, IOCON_FUNC2);
     }
}

/* Initialize pin muxing for SPI interface */
void Board_SPI_Init(bool isMaster)
{
     /* Set up clock and muxing for SSP0 interface */
     /*
      * Initialize SSP0 pins connect
      * P0.15: SCK
      * P0.16: SSEL
      * P0.17: MISO
      * P0.18: MOSI
      */
     Chip_IOCON_PinMux(LPC_IOCON, 0, 15,
IOCON_MODE_PULLDOWN, IOCON_FUNC3);
     if (isMaster) {
         Chip_IOCON_PinMux(LPC_IOCON, 0, 16,
IOCON_MODE_PULLUP, IOCON_FUNC0);
         Chip_GPIO_WriteDirBit(LPC_GPIO, 0, 16, true);
         Board_SPI_DeassertSSEL();

     }
     else {
```

```
		Chip_IOCON_PinMux(LPC_IOCON, 0, 16,
IOCON_MODE_PULLUP, IOCON_FUNC3);
	}
	Chip_IOCON_PinMux(LPC_IOCON, 0, 17, IOCON_MODE_INACT,
IOCON_FUNC3);
	Chip_IOCON_PinMux(LPC_IOCON, 0, 18, IOCON_MODE_INACT,
IOCON_FUNC3);
}

/* Assert SSEL pin */
void Board_SPI_AssertSSEL(void)
{
	Chip_GPIO_WritePortBit(LPC_GPIO, 0, 16, false);
}

/* De-Assert SSEL pin */
void Board_SPI_DeassertSSEL(void)
{
	Chip_GPIO_WritePortBit(LPC_GPIO, 0, 16, true);
}

void Board_Audio_Init(LPC_I2S_T *pI2S, int micIn)
{
	I2S_AUDIO_FORMAT_T I2S_Config;

	/* Chip_Clock_EnablePeripheralClock(SYSCTL_CLOCK_I2S);
*/

	I2S_Config.SampleRate = 48000;
	I2S_Config.ChannelNumber = 2;    /* 1 is mono, 2 is
stereo */
	I2S_Config.WordWidth =  16;      /* 8, 16 or 32 bits */
	Chip_I2S_Init(pI2S);
```

```
    Chip_I2S_TxConfig(pI2S, &I2S_Config);
}

/* Sets up board specific I2C interface */
void Board_I2C_Init(I2C_ID_T id)
{
    switch (id) {
    case I2C0:
        Chip_IOCON_PinMux(LPC_IOCON, 0, 27,
IOCON_MODE_INACT, IOCON_FUNC1);
        Chip_IOCON_PinMux(LPC_IOCON, 0, 28,
IOCON_MODE_INACT, IOCON_FUNC1);
        Chip_IOCON_SetI2CPad(LPC_IOCON,
I2CPADCFG_STD_MODE);
        break;

    case I2C1:
        Chip_IOCON_PinMux(LPC_IOCON, 0, 19,
IOCON_MODE_INACT, IOCON_FUNC2);
        Chip_IOCON_PinMux(LPC_IOCON, 0, 20,
IOCON_MODE_INACT, IOCON_FUNC2);
        Chip_IOCON_EnableOD(LPC_IOCON, 0, 19);
        Chip_IOCON_EnableOD(LPC_IOCON, 0, 20);
        break;

    case I2C2:
        Chip_IOCON_PinMux(LPC_IOCON, 0, 10,
IOCON_MODE_INACT, IOCON_FUNC2);
        Chip_IOCON_PinMux(LPC_IOCON, 0, 11,
IOCON_MODE_INACT, IOCON_FUNC2);
        Chip_IOCON_EnableOD(LPC_IOCON, 0, 10);
        Chip_IOCON_EnableOD(LPC_IOCON, 0, 11);
        break;
```

```
     }
}

void Board_Buttons_Init(void)
{
     Chip_GPIO_WriteDirBit(LPC_GPIO,
BUTTONS_BUTTON1_GPIO_PORT_NUM,
BUTTONS_BUTTON1_GPIO_BIT_NUM, false);
}

uint32_t Buttons_GetStatus(void)
{
     uint8_t ret = NO_BUTTON_PRESSED;
     if (Chip_GPIO_ReadPortBit(LPC_GPIO,
BUTTONS_BUTTON1_GPIO_PORT_NUM,
BUTTONS_BUTTON1_GPIO_BIT_NUM) == 0x00) {
          ret |= BUTTONS_BUTTON1;
     }
     return ret;
}

/* Baseboard joystick buttons */
#define NUM_BUTTONS 5
static const uint8_t portButton[NUM_BUTTONS] = {
     JOYSTICK_UP_GPIO_PORT_NUM,
     JOYSTICK_DOWN_GPIO_PORT_NUM,
     JOYSTICK_LEFT_GPIO_PORT_NUM,
     JOYSTICK_RIGHT_GPIO_PORT_NUM,
     JOYSTICK_PRESS_GPIO_PORT_NUM
};
static const uint8_t pinButton[NUM_BUTTONS] = {
     JOYSTICK_UP_GPIO_BIT_NUM,
     JOYSTICK_DOWN_GPIO_BIT_NUM,
     JOYSTICK_LEFT_GPIO_BIT_NUM,
     JOYSTICK_RIGHT_GPIO_BIT_NUM,
     JOYSTICK_PRESS_GPIO_BIT_NUM
};
static const uint8_t stateButton[NUM_BUTTONS] = {
     JOY_UP,
     JOY_DOWN,
     JOY_LEFT,
     JOY_RIGHT,
     JOY_PRESS
};

/* Initialize Joystick */
void Board_Joystick_Init(void)
{
     int ix;

     /* IOCON states already selected in SystemInit(), GPIO
setup only. Pullups
        are external, so IOCON with no states */
     for (ix = 0; ix < NUM_BUTTONS; ix++) {
          Chip_GPIO_SetPinDIRInput(LPC_GPIO, portButton[ix],
pinButton[ix]);
     }
}

/* Get Joystick status */
uint8_t Joystick_GetStatus(void)
{
     uint8_t ix, ret = 0;

     for (ix = 0; ix < NUM_BUTTONS; ix++) {
          if ((Chip_GPIO_GetPinState(LPC_GPIO,
portButton[ix], pinButton[ix])) == false) {
              ret |= stateButton[ix];
         }
     }

     return ret;
}


void Serial_CreateStream(void *Stream)
{}

void Board_USBD_Init(uint32_t port)
{
     /* VBUS is not connected on the NXP LPCXpresso
LPC1769, so leave the pin at default setting. */
     /*Chip_IOCON_PinMux(LPC_IOCON, 1, 30,
IOCON_MODE_INACT, IOCON_FUNC2);*/ /* USB VBUS */

     Chip_IOCON_PinMux(LPC_IOCON, 0, 29, IOCON_MODE_INACT,
IOCON_FUNC1); /* P0.29 D1+, P0.30 D1- */
     Chip_IOCON_PinMux(LPC_IOCON, 0, 30, IOCON_MODE_INACT,
IOCON_FUNC1);

     LPC_USB->USBClkCtrl = 0x12;                /* Dev, AHB
clock enable */
     while ((LPC_USB->USBClkSt & 0x12) != 0x12);
}
```