Jason Mensah-Homiah (jm2jy)

CS 6501-013 Advanced Embedded Systems

Mini Project 1

02/14/2025

DELIVERABLES

1. Code for the functions:
    - BSP_LCD_Message

```
void BSP_LCD_Message (int device, int line, int col, char *string, unsigned int value){
    if (device == 0) {
        if (line > 11 || col > 20) return;

        // Seting cursor and draw the string
        BSP_LCD_SetCursor(col, line);
        BSP_LCD_DrawString(col, line, string, ST7735_WHITE);

        // Moving the cursor to where the value should appear
        BSP_LCD_SetCursor(col + strlen(string), line);

        // Outputting the value using BSP_LCD_OutUDec
        BSP_LCD_OutUDec(value, ST7735_WHITE);
    } else if (device == 1) {
        if (line != 0 || col > 20) return;

        // Setting cursor and draw the string
        BSP_LCD_SetCursor(col, 12);
        BSP_LCD_DrawString(col, 12, string, ST7735_WHITE);

        // Moving the cursor to where the value should appear
        BSP_LCD_SetCursor(col + strlen(string), 12);

        // Outputting the value using BSP_LCD_OutUDec
        BSP_LCD_OutUDec4(value, ST7735_WHITE);
    }
}
```

    - BSP_LCD_DrawCrosshair

```
void BSP_LCD_DrawCrosshair(int16_t x, int16_t y, int16_t color) {
    // The size of the crosshair (half the length of each line)
    int16_t crossSize = 5;

    // Adjusting coordinates to ensure the entire crosshair is within bounds
    if (x - crossSize < 0+4) {
        x = crossSize; // Ensure the left part of the crosshair is within bounds
    } else if (x + crossSize >= ST7735_TFTWIDTH) {
        x = ST7735_TFTWIDTH - crossSize - 1; // Ensuring the right part of the crosshair is within bounds
    }

    if (y - crossSize < 0+4) {
        y = crossSize; // Ensure the top part of the crosshair is within bounds
    } else if (y + crossSize >= ST7735_TFTHEIGHT) {
        y = ST7735_TFTHEIGHT - crossSize - 1; // Ensuring the bottom part of the crosshair is within bounds
    }

    // Calculating the bounds for the horizontal and vertical lines of the crosshair
    int16_t leftX = x - crossSize; // Start of the horizontal line
    int16_t rightX = x + crossSize; // End of the horizontal line
    int16_t topY = y - crossSize; // Start of the vertical line
    int16_t bottomY = y + crossSize; // End of the vertical line

    // Drawing the horizontal line of the crosshair
    BSP_LCD_DrawFastHLine(leftX, y, rightX - leftX + 1, color);

    // Drawing the vertical line of the crosshair
    BSP_LCD_DrawFastVLine(x, topY, bottomY - topY + 1, color);
}
```


jm2jy@virginia.edu

- InitTimer1A

```
// Configure Timer1A
void InitTimer1A(unsigned long period, unsigned long priority)
  long sr;
  volatile unsigned long delay;

  sr = StartCritical();
  SYSCTL_RCGCTIMER_R |= 0x02;
  while((SYSCTL_RCGCTIMER_R & 0x02) == 0){} // allow time for

  TIMER1_CTL_R &= ~TIMER_CTL_TAEN;
  TIMER1_CFG_R = TIMER_CFG_32_BIT_TIMER;
  TIMER1_TAMR_R = TIMER_TAMR_TAMR_PERIOD;
  TIMER1_TAILR_R = period - 1;
  TIMER1_ICR_R = TIMER_ICR_TATOCINT;
  TIMER1_IMR_R |= TIMER_IMR_TATOIM;
  NVIC_PRI5_R = (NVIC_PRI5_R & 0xFFFF00FF)|(priority << 13);
  NVIC_EN0_R = NVIC_EN0_INT21;
  TIMER1_TAPR_R = 0;
  TIMER1_CTL_R |= TIMER_CTL_TAEN;
  EndCritical(sr);
}
```

- OS_AddPeriodicThread

```
int OS_AddPeriodicThread(void(*task)(void), unsigned long period, unsigned long priority) {
  if (PeriodicTask != 0) {              // Checking if a periodic task is already running
    return 0;                           // Return 0 if the thread cannot be added
  }
  PeriodicTask = task;                  // Assign the task to the global function pointer
  InitTimer1A(period, priority);        // Initializing Timer1A with the specified period and priority
  return 1;
}
```

- Producer

```
//******** Producer ***************
void Producer(void){
#if TEST_TIMER
  PE1 ^= 0x02;  // heartbeat
  Count++;  // Increment dummy variable
#else
  // Variable to hold updated x and y values
  int16_t newX = x;
  int16_t newY = y;
  int16_t deltaX = 0;
  int16_t deltaY = 0;

  uint16_t rawX, rawY; // To hold raw adc values
  uint8_t select; // To hold pushbutton status
  rxDataType data;
  BSP_Joystick_Input(&rawX, &rawY, &select);

  // Your Code Here

  int16_t crosshairAreaHeight = 10;


  // Calculating deltas based on raw ADC values and origin
  deltaX = ((int16_t)rawX - (int16_t)origin[0]) / 512;
  deltaY = -((int16_t)rawY - (int16_t)origin[1]) / 512; // Negated deltaY to fix inverted Y-axis

  // Updating crosshair position based on deltas
  newX += deltaX;
  newY += deltaY;

  // Defining the size of the crosshair (half the length of each line)
  int16_t crossSize = 5;

  // Clamping crosshair position to ensure it stays within valid range [0, 127]
  if (newX < crossSize) newX = crossSize;
  if (newX > 127 - crossSize) newX = 127 - crossSize;
  if (newY < crossSize) newY = crossSize;
  if (newY > 127 - crossSize - crosshairAreaHeight) newY = 127 - crossSize - crosshairAreaHeight;

  // Updating global crosshair position
  x = (uint32_t)newX;
  y = (uint32_t)newY;

  // Preparing data for FIFO
  data.x = x;
  data.y = y;

  // Pushing data into the FIFO
  RxFifo_Put(data);
#endif
}
```


jm2jy@virginia.edu

- Consumer

```
//******** Consumer ***************
void Consumer(void){
  rxDataType data;

    // Checking if there's new data in the FIFO
    if (RxFifo_Get(&data)) {

        // Erasing the previous crosshair
        BSP_LCD_DrawCrosshair(prevx, prevy, BGCOLOR);

        // Drawing the new crosshair
        BSP_LCD_DrawCrosshair(data.x, data.y, LCD_RED);

        // Displaying the X and Y positions
        BSP_LCD_Message(1, 0, 4, "X:", data.x);
        BSP_LCD_Message(1, 0, 12, "Y:", data.y);

        // Updating the previous position for the next iteration
        prevx = data.x;
        prevy = data.y;
    }
}
```

2. calculations for TEST_PERIOD to get a frequency of 20 Hz, and the snapshot of the logic analyzer or oscilloscope measuring timer frequency at 20 Hz:

Period = 1 / Frequency

= 1 / 20 = 0.05 seconds (50 ms)

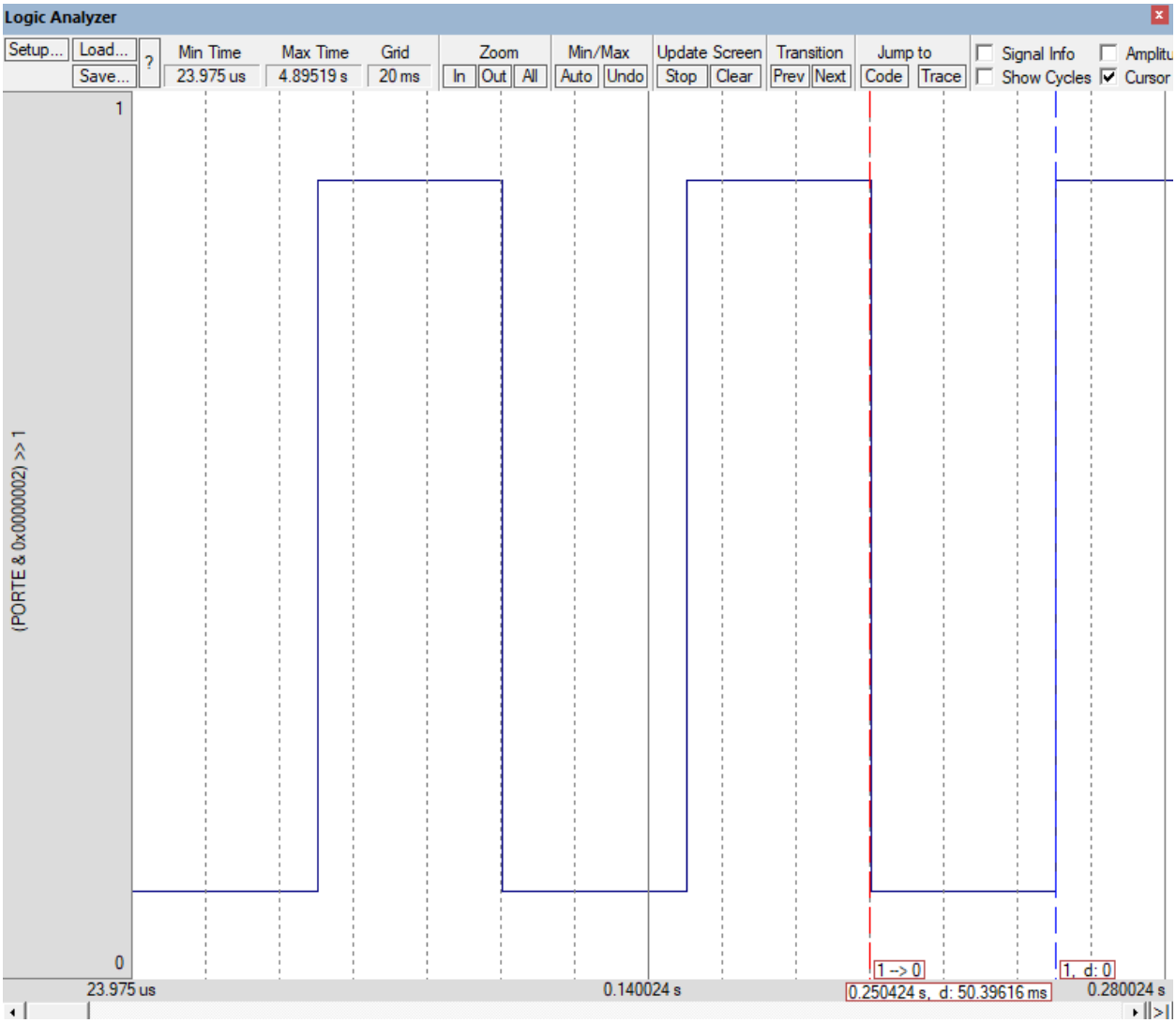
TEST_PERIOD = Period * Clock Frequency

= 0.05 * 80 MHz

= 4000000

As indicated in the screenshot below:

jm2jy@virginia.edu



3. Link to video recording demonstrating the required functionality: https://youtube.com/shorts/k4OC2mR9-uI?si=KmC3wmwtNkPO5yBs

jm2jy@virginia.edu