In-Class Activity: BLINK – Programming LEDs with Data Analysis

This in-class activity guides you through programming two built-in LEDs on the MSP430FR5994 and includes seven (7) deliverables.

Purpose of this project: Imagine you work for a toy design company. The client wants a simple prototype that uses two LEDs to capture children's attention. Your mission is to learn how to control the built-in LEDs of the MSP430FR5994 board: turn them on, change their blinking speed, alternate between them, and finally program a small pattern that combines both colors. The toy company also wants data to support design decisions. They need to know how consistent the LED blinking is and how children might perceive it at different speeds. To test this, your team will program a 1-second blink interval and then measure it manually with a stopwatch, introducing human error that you can analyze statistically.

Your Task: Your task is to demonstrate that you can control the microcontroller and analyze the results of your prototype.
You must accomplish the following:

1. Turn on one of the LaunchPad LEDs (green or red).
2. Change the blinking speed of that LED.
3. Turn on the second built-in LED.
4. Create an alternating blinking pattern between the green and red LED.
5. Program the LED blinking interval to 2 seconds using ***delay(2000).***
6. Measure the ON and OFF times manually with a stopwatch for at least 10 cycles (this will incorporate human error).
7. Record your data in Excel, calculate descriptive statistics (mean, standard deviation, minimum, maximum), and create a graph of the results.

Organizing Your Work
Pay attention to how you format and organize your work in your Excel file and Word document. Below are some general instructions:

- Clearly label your tables and charts in Excel.
- Show your calculations for descriptive statistics (mean, standard deviation, min, max).
- Insert your diagram, pseudocode, final code, and picture of your board into your Word file.
- Combine your Excel results and Word file into a single submission when possible.

Submission Instructions:

- Complete this assignment **as a team.** One team member of your team must submit your work on Gradescope, listing each member of your team in the submission process. All team members should review and approve the submission.

Deliverables

- **Word file (with diagram, pseudocode, final code, and picture of your board).**
  Name your Word file: ENGR131_ICA_Blink.docx
- **Excel file (with raw data, descriptive statistics, and charts).**
  Name your Excel file: ENGR131_ICA_Blink.xlsx

Submit your work through the designated **Brightspace In-Class Activity Drop Box**.

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Deliverables:

1. A simple block diagram that demonstrates the information flow (microcontroller → LED).
2. A pseudocode or flowchart that demonstrates the order of the main steps your microcontroller uses to blink the LEDs.
3. A copy of the final Energia code your team developed.
4. A picture of the physical prototype (your LaunchPad with the LEDs blinking).
5. An Excel file with your recorded ON/OFF times measured with a stopwatch.
6. A summary table of descriptive statistics (mean, standard deviation, minimum, maximum).
7. At least one chart (line, bar, or histogram) showing the measured blinking intervals compared to the expected value (2 seconds).

Background/Technical Content:

The first visible light-emitting diode (LED) was demonstrated in **1962** by Nick Holonyak Jr., emitting red light using gallium arsenide phosphide. Over time, advances in semiconductor materials expanded the range of colors and significantly improved brightness and efficiency. These developments transformed LEDs from simple indicator lights in electronics to widespread applications in toys, mobile phones, medical equipment, and traffic signals, valued for their low power consumption, durability, and versatility (Dupuis & Krames, 2008).

The **MSP430FR5994 LaunchPad** includes **two built-in programmable LEDs** (Figure 1):

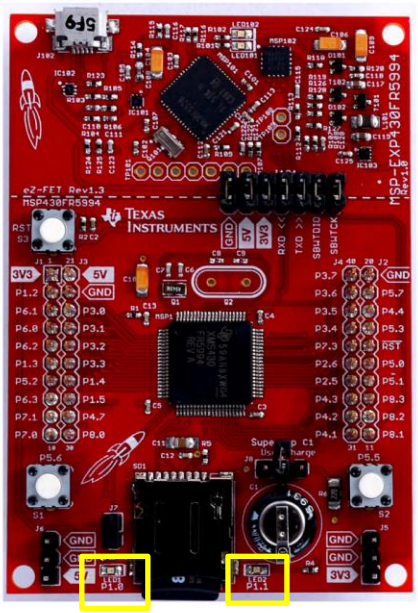

Figure 1: Red and Green user LEDs on the MSP430FR5994 LaunchPad (Pins P1.0 and P1.1)

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These LEDs can be programmed through the Energia IDE using simple ON/OFF commands. By adjusting the timing with the ***delay()*** function, engineers can create different blink rates and patterns to signal various system states. For example, alternating red and green could simulate device status indicators similar to those used in electronic toys.

In this activity, students will program a **2-second blink intervals** (delay(2000)) and then measure the ON and OFF times manually with a stopwatch. Because human reaction time is not perfectly accurate, the measured data will naturally differ from the programmed value. This **human error** provides an opportunity to apply descriptive statistics to quantify variability.

Key statistical measures include the mean (average), standard deviation (spread of the data), and the minimum and maximum values (extremes). Visualizing these results with charts (line graphs, bar charts, or histograms) makes it easier to compare the expected blink interval (2 seconds) with the observed measurements. This process models how engineers validate system performance through both programming and data analysis.

References

Dupuis, R. D., & Krames, M. R. (2008). History, development, and applications of high-brightness visible light-emitting diodes. *Journal of Lightwave Technology, 26*(9), 1154–1171. https://doi.org/10.1109/JLT.2008.923628

Learning Objectives Your work will be graded on demonstration of proficiency of the following learning objectives:	**Did you address this?**
UC02 – Describe systems or processes using schematic diagrams with inputs, outputs, and accumulations	
IF03 – Generate testable prototypes for a set of potential solutions.	
DV01 – Efficient use of engineering tools for basic statistics (Excel functions)	
PC05 - Fully address all parts of assignment by following instructions and completing all work.	
TW02 - Document all contributions to the team performance with evidence that these contributions are significant.	
DV02 – Select appropriate graphical representation of dataset based on data characteristics.	
DV05 – Prepare a chart for technical presentation with proper formatting.	

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DV06 – Describe the central tendency of data using descriptive statistics (mean, median, mode).	
DV07 – Describe variability of data using statistical methods (standard deviation, variance).	