ENGR 131 In-Class Activity: Smart Light

Instruction

This in-class activity guides you through designing a smart lighting system that integrates light and ultrasonic sensors with logic structures to control an LED. There are four (4) deliverables.

Purpose of this project: The purpose of this activity is to guide you in building a smart lighting system that responds intelligently to environmental changes. Using a light sensor, you will detect ambient brightness, and with an ultrasonic ranger, you will detect nearby objects. By applying logical operators (AND / OR) within your code, you will combine these sensor inputs to control when an LED turns on — for example, turning on the LED only when it is dark and someone is nearby. This project demonstrates how multiple sensors can work together through simple logic to enable more responsive and energy-efficient systems, similar to those found in real-world smart homes and safety applications. Along the way, you will also explore different logic structures, observe their effects, and reflect on how system behavior changes with different conditions.

Your Task: Your task is to demonstrate that you can

1. Integrate multiple sensors with the microcontroller
2. Apply and modify logical selection structures in code
3. Understand how logic affects system behavior

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:

- Insert your diagram, pseudocode, and final code into your Word file.

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_TeamNumber.docx

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

Deliverables:

1. Write a clear pseudocode or flowchart that describes the logic controlling the LED using AND and OR operators.
2. Combine and modify code from the light and ultrasonic examples to implement the smart lighting behavior.
3. Test the system under different light and distance conditions and observe how different logic operators affect the LED response.
4. Experiment with and reflect on alternative logic structures to see how system behavior changes and discuss potential real-world applications.

Background/Technical Content:

Light sensors are devices that measure the intensity of ambient light and convert it into an electrical signal that can be processed by a microcontroller (Analog Devices, n.d.). A common type used in educational and prototyping settings is the Light-Dependent Resistor (LDR), also known as a photoresistor (Shawn. 2020).

Figure 1. Grove Light Sensor

An LDR is made of a semiconducting material whose electrical resistance decreases as light intensity increases. In dark conditions, few charge carriers are available, resulting in high resistance (hundreds of kΩ). In bright conditions, incident photons excite electrons in the material, increasing conductivity and reducing resistance (to a few kΩ or less).

To interface the LDR with a microcontroller, it is typically connected in a voltage divider circuit. As light levels change, the varying resistance causes the output voltage of the divider to change proportionally. This analog voltage is then fed into the microcontroller's Analog-to-Digital Converter (ADC). For a 10-bit ADC, the input voltage is mapped to a digital value between 0 and 1023, corresponding to 0 V and the reference voltage (usually 3.3 V or 5 V), respectively.

By selecting appropriate threshold values, the system can classify light levels (e.g., "bright" vs "dark") and use these readings in control logic—for example, automatically turning on a light when it gets dark.

Light sensors are widely used in automatic lighting, display brightness control, security systems, and environmental monitoring, making them a fundamental sensing component in many smart systems.

References

Analog Devices. (n.d.). *Light sensor*. Analog Devices. https://www.analog.com/en/resources/glossary/light-sensor.html

Shawn. (2020, January 8). *What is a light sensor? Types, uses, Arduino guide*. Seeed Studio. https://www.seeedstudio.com/blog/2020/01/08/what-is-a-light-sensor-types-uses-arduino-guide/

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.	