The University of Jordan

Embedded Systems Lab

Spring 2023

Project: Object-Counting System

Group Size	Grading	Due Date
2-4 Students	20 Points	**Saturday 27/05/2023 Before 23:59**

Project Details and Description

Counting products has been very important in industrial facilities and is highly subject to human errors. Automatic counting of objects can also be used in any public transportation system such as trains to count the number of passengers for monitoring purpose. In this project, you are required to address this problem from an embedded- system engineering viewpoint. Basically, you are required to design and implement a simple embedded system that counts objects in an industrial facility, monitors the counting operation and displays the count on two seven-segment displays. The system has an LED and a buzzer that are activated when the number of objects is above or below certain limit.

The general setup of the industrial environment to be considered is shown in Figure 1. The products in the facility can move on a conveyor belt in two directions. To count the objects moving in both directions, two infrared sensors (IR) are positioned on the belt as shown in Figure 1. The IR sensor consists of one IR transmitter and one IR receiver that are aligned opposite to each other in line of sight. When an object blocks the infrared beam generated by the transmitter, the output voltage level of the receiver changes. This change can be used to detect that there is an object by monitoring the voltage level using a PIC16F877A microcontroller. The moving object first blocks one of the beams, hence the motion direction can be inferred; right-to-left or left-to-right. The system should update the count value when an object crosses the beams of the two sensors only.

The count is tracked by the MC, and then displayed on two seven-segment displays. The buzzer is activated whenever the count value is updated. When the count value is greater than C_{max} or less then C_{min}, the LED flashes and the buzzer is activated for T seconds. The values of T, C_{max} and C_{min} are design parameters that you need to specify.

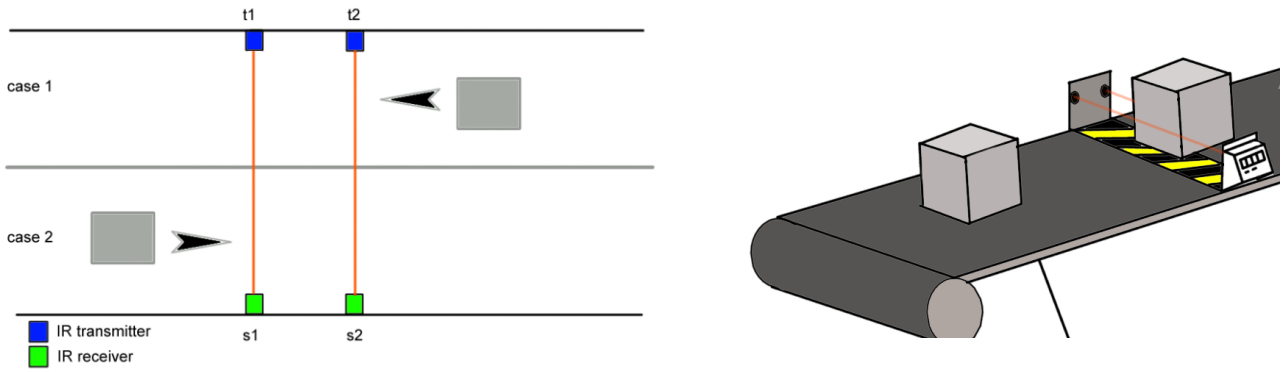

Figure-1: General setup of the counting system

The counting operation in the system is as follows: **1) Case 1:** Object entering from right to left (considered as forward motion). In this case, the count value is incremented by 1 when the object blocks the t2 sensor then the t1 sensor. The object is not counted If blocks the t2 sensor only.

2) Case 2: Object entering from left to right (considered as reverse motion). In this case, the count value is decremented by 1 when the object blocks the t1 sensor then the t2 sensor. The object is not counted If blocks the t1 sensor only.

The sensors are interfaced to the MC, which is responsible for tracking the count and displaying it on two seven-segment displays. The buzzer is activated for 0.5 seconds whenever the count value is updated. When the count value is greater than C_{max} or less then C_{min}, the LED flashes and the buzzer is activated for T seconds. The values of T, C_{max} and C_{min} are design parameters that you need to specify. All timing operations in the system should be through hardware timers. Also, you should use seven-segment multiplexing to interface them to the microcontroller. Moreover, the system has a PUASE switch. When the switch is closed, the system stops counting regardless of the number of objects that pass by. Otherwise, the system operates normally when the switch is open.

Design and Development

For this project, you are required to design, implement and test the system in simulation using MPALB and Proteus, and then build the **hardware prototype for the system**. For the software part, you need to **program in assembly**, and you are encouraged to maximize the use of interrupts, subroutines and hardware timers in your design. Make sure to include detailed explanation for your design and all the calculations that you do.

Project Groups

You must form groups of **two to four** students to work on this project. We prefer that you form groups from within your own lab session, but if you cannot find a partner, then you can form a group with colleagues from the other sessions. Please fill in the names of your team members using the following Google form by **19/05/2023. One form is required for each group. For those who don't fill the form, they will be grouped randomly with each other.**

[Google Form Link]

WE ARE NOT RESPONSIBLE IF YOU CANNOT FIND PARTNERS, OR IF YOUR PARTNER IS NOT GIVING ENOUGH EFFORT, OR DROPS THE COURSE!

Important Notes

- **Start as early as possible** on your project, though the project description sounds simple, there is inherent complexity in both hardware and software aspects, so do not underestimate the time it needs, you will have many problems along the way which you will have to resolve!
- **Never think of buying a model or commissioning someone to do it for you**, not only will you get a zero in the project, but also your act will be considered as a direct violation to JU laws and your actions shall be reported as cheating in the final exam!
- **Code sharing** between groups is NOT allowed and leads to 0 points.
- If you acquire a ***part*** of your software from a book, website, etc, then kindly reference it properly, else it will be considered as plagiarism.
- You are only allowed to base your project on ***PIC16F77A***.
- You are free to use any material to build the model and the holding structure of the hardware devices you use. You might use LEGO parts, wood, strengthened cartoon, or even metallic components.
- All programming must be done in **PIC ASSEMBLY** language only; using high-level programming languages in this project will get you a zero.
- Your submitted work must be professional:
    - **Hardware**: you are submitting a product, all electrical and electronic components must be hidden from the user, only user-accessed components are visible. Hide the wiring, be neat. ***Still, the instructor should be able to easily examine the internal components at the time of discussion when required.***
    - **Software**: your work should be fully documented, all inputs/outputs should be listed, and each sub-routine/macro should be fully documented. Use functional comments> Refer to the last section in Experiment 2 regarding documentation.
- Divide the work such that each student is responsible for a specific task, **YET EVERY** student is required to answer for **ANY QUESTIONS** in relation to any submitted work of the project.

Report Guidelines

You should submit a report and it should contain the following parts:

• **Introduction.** In this section, you give a brief description of the overall project in your own technical language.

• **System Description.** Here you give a detailed description of the system design and how it was decomposed into subsystems.

• **Hardware System.** Here you must explain and elaborate on your system hardware design, its inputs and outputs. Present a clear and professional circuit design schematic. **Justify why you configured and initialized your system and modules in this way.**

• **System Testing and Results.** Present the complete methodology which you have undertaken to perform unit testing, system integration, and the final overall test. You must present the test cases which you have used to test your system for correct functionality. You must justify the choices for your test cases and whether or not they cover all possible regions of operation of your system. Provide technical discussion of the results or any abnormal operation you have witnessed during testing. **See the grading sheet for more details**

• **Conclusion.** Give a short summary of the project, your work, and the steps you have undertaken during the design process. Furthermore, you must clearly state the contribution of each student in the project. Discuss the major obstacles that you faced during the design process.

Submission

For this project, you need to submit a single compressed file that contains a detailed report of your system and the MPLAB and Proteus files through MS Teams before 23:59 of 27/05/2023. An assignment will be created for this purpose.

Each team are required to attend a discussion session in which they submit a hard-copy of the report and present the hardware prototype for their system, and be ready to answer questions and demonstrate their system to the lab engineer to during the week of 28/05/2023. The discussion schedule will be announced later.