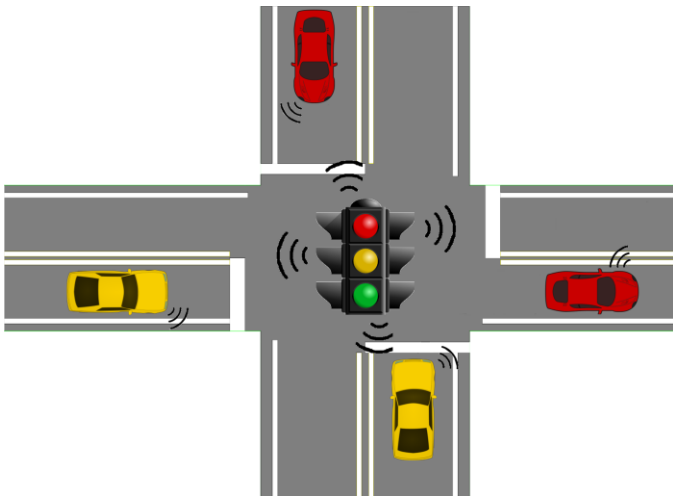
UNIVERSITY OF JORDAN

Embedded Systems Lab

Dynamic Traffic and Street Lights Controller with Non-Motorized User Detection



Preferred Group Size	Grading	Project Due Date
(2) Two is the allowed group size.	**(15)** 15 marks is the project weight.	**(Dec,10th)** The deadline for the project is the week of December 10th 2017.

Project Description

In this project you are required to implement a controller that dynamically controls traffic and street lights according to light intensity, vehicle intensity, and non-motorized user detection. To reduce complexity and cost, we assume a 2-street intersection (i.e. each street is one-way). Each street has a 3-color (Red, Orange, and Green) traffic light and two passive infrared sensors (PIR) mounted at different distances from the traffic light as shown in Figure 1.

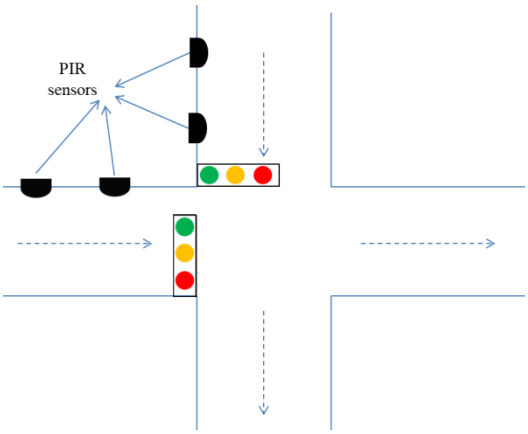


Figure 1: Two-Street Junction with PIR Sensors

The PIR sensors are responsible for tracking the intensity of vehicles on both streets and classifying it into three categories: low, medium, and high. Moreover, a light dependent resistor (LDR) is used to measure light intensity needed to switch between day and night modes for the traffic and street lights. Lastly, the presence of non-motorized individuals is detected manually using four push buttons mounted at the four corners. To reduce cost, only one push button is used in the implementation. The data collected from the PIR sensors, LDR, and the push button is used to dynamically control the traffic and street lights as will be explained in the functionality section below.

Hardware Layout

This project requires a single PIC microcontroller with different input and output devices connected to it as shown in the following figure:

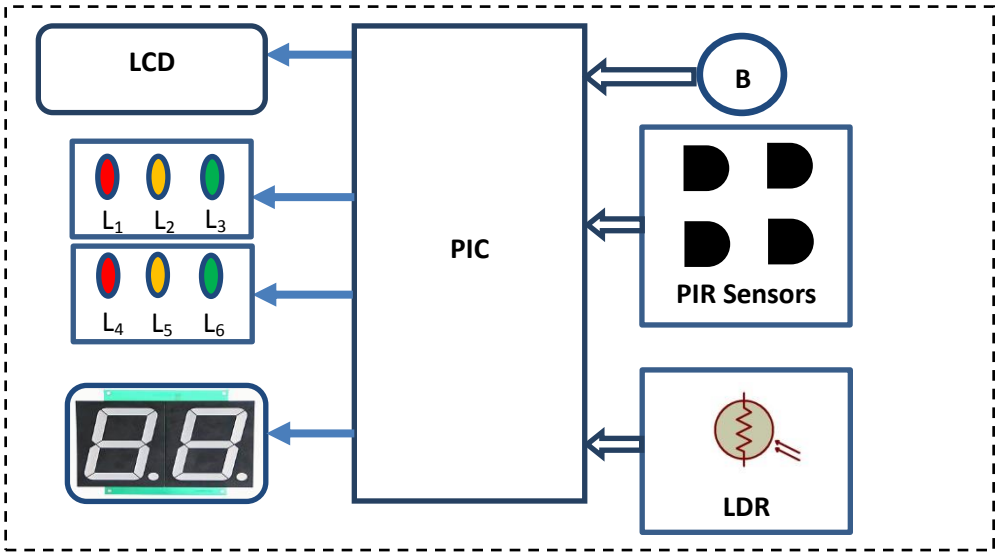


Figure 2: Project Layout

The PIC is the main engine in the design and it is connected to the following input devices:

- The push button marked with "**B**" in Figure 2 which is responsible for notifying the PIC about the existence of any non-motorized individuals.
- Four PIR sensors which are responsible for tracking the vehicle intensity of both streets.
- A single LDR which is responsible for measuring the light intensity.

The PIC is simultaneously connected to the following output devices:

- An LCD which displays the current status of street lights and the appropriate non-motorized individuals sign.
- Six LEDs (i.e. three per traffic light).
- Two-digit 7-segment display which displays the remaining time available for non-motorized individuals to cross the street junction.

Functionality

The functionality of the controller depends on the current mode which is specified by the LDR. There are two modes of operation: day mode (i.e. high light intensity detected) and night mode (i.e. very low light intensity detected).

Day Mode Operation:

During day mode, the street lights are clearly OFF. This is represented by a statement displayed at the lower line of the LCD such as "Lights are OFF". Regarding the two traffic lights, they become Green in a round robin fashion continuously. Notice that the traffic light should go directly from Red to Green. On the other hand, the traffic light should go from Green to Orange then from Orange to Red. ***The Orange light retains for a period of 3 seconds***. The period of the Green light depends on the latest vehicle intensity detected by the PIR sensors of the respected street as given by Table 1.

Table 1: Green Light Period vs Vehicle Intensity during Day Mode

Vehicle Intensity	Green Light Period (Seconds)
Low	15
Medium	30
High	60

The vehicle intensity is determined according to the input received from the respected PIR sensors shortly **before** the traffic light should go from Red to Green as given by Table 2. Notice that the proximity of the PIR sensors is based on their locations with respect to the traffic light of the street they are mounted at.

Table 2: Vehicle Intensity Categorization

Closer PIR Sensor Input	Farther PIR Sensor Input	Vehicle Intensity
No Vehicles are detected	X	Low
Vehicles are detected	No Vehicles are detected	Medium
Vehicles are detected	Vehicles are detected	High

When non-motorized individuals are detected through the push button, the controller waits for the current Green traffic light to become Red then the "walking sign" (e.g. Figure 3) is displayed at the upper LCD line with a flashing style (i.e. ON and OFF continuously). Simultaneously, the two-digit 7-segment display shows a 45 seconds count down timer. When the timer is OFF, the "stop sign" (e.g. Figure 4) is displayed at the upper LCD line and traffic light in turn becomes Green. Notice, that the "stop sign" is continuously displayed as long as no non-motorized individuals are detected.

Figure 3: Walking Sign

Figure 4: Stop Sign

Night Mode Operation:

During night mode, the street lights are ON as long as vehicles are sensed on any street. When no vehicles are sensed on both streets, the lights are turned OFF for a period of three minutes before vehicles are checked again. After the three minutes period finishes, if no vehicles are sensed the lights continue in the OFF state. When any vehicle is sensed after the three minutes period finishes, the street lights are turned ON for a minimum of two minutes. Similar to the day mode, the street lights status during night mode should be indicated by a statement displayed at the lower line of the LCD (i.e. Lights are OFF or Lights are ON).

The operation of the two traffic lights during night mode depends on the vehicle intensity of their respective streets. At any point of time, the traffic light of one street will be Red and as long as no vehicles are sensed on that street its traffic light will continue to be Red while the other will continue to be Green. When any vehicle is sensed on the street with the Red traffic light, the traffic light of the other street should go from Green to Red after 30 seconds. Subsequently, the traffic light which was originally Red goes to Green for a minimum of 30 seconds.

When non-motorized individuals are detected during night mode, the controller waits for 30 seconds before changing the current Green traffic light to Red then the "walking sign" is displayed at the upper LCD line with a flashing style (i.e. ON and OFF continuously). Simultaneously, the two-digit 7-segment display shows a 45 seconds count down timer. When the timer is OFF, the "stop sign" is displayed at the upper LCD line. At this point, if there are any vehicles sensed at the traffic light which was Red when the non-motorized individuals were detected, then this traffic light goes from Red to Green. Otherwise, the same traffic light which was Green when the non-motorized individuals were detected goes from Red to Green again.

When non-motorized individuals are detected during night mode, the street lights should become ON at the same time when the "walking sign" is displayed regardless of their current status. The street lights stay ON for a minimum period of four minutes before vehicle intensity is checked to decide whether to turn OFF the street lights immediately (i.e. when no vehicles are sensed) or keep them ON otherwise.

Please note that there are many input and output devices connected to the PIC and you may end up sharing an 8-bit port between the LCD and the two-digit 7-segment display. In addition, you are free to replace each PIR sensor with a pair of IR LED and photodiode.

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 … kindly reference it properly, else it will be considered as plagiarism.

- You are only allowed to base your project on PIC16877a.

- All programming must be done in **PIC ASSEMBLY** language only; using high level languages in the 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 easily able to 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 subroutine/macro should be fully documented! Use functional comments! Refer to the last section in experiment 2 regarding documentation.

- You should submit two types of flowcharts:
  1. An abstract general flowchart of the whole program.
  2. A flowchart for each of your subroutines/macros (except codes taken from lab experiments).

- Students are not allowed to move between groups once they are formed, so choose your group carefully from the beginning! ***We are not responsible if your colleagues in the group chose to drop the class, we will not allow you to join another group!***

- 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 hard copy of your report and it should contain the following parts:

- Introduction
- System requirements
- Subsystems description along with their respective flowcharts (as described in the notes section)
- Circuit diagram of your hardware (use Proteus to draw the circuit) with a brief description
- Snap shots of the actual hardware implementation with a brief description
- The final outputs (i.e. which parts of the system are working on Proteus or on real hardware)
- The contribution of each student in the project
- Major obstacles faced during the design process

Good Luck and Have Fun Building the Project