Embedded System HW3 Written Document

Question 1) How do you know that your Raspberry Pi GPIO pins are in safe states at the end of your code? Why is this important?

Answer1) Being Configured to (PI_LOW) at the end of the loop and then being set to (PI_INPUT) before terminating the code denotes that gpio pins for the respective led are in the safe state.

ensuring that GPIO pins are left in safe states at the end of a program or operation is crucial for both hardware protection and energy efficiency. Leaving pins in an undefined or floating state can lead to unintended behavior, such as noise interference, accidental triggering of connected devices, or even hardware damage due to short circuits or overcurrent. Setting GPIO pins to a defined low-power state (such as input mode with pull-up or pull-down resistors) reduces power consumption and protects connected peripherals. This practice is especially important in systems where reliability and hardware longevity are priorities.

Question 2) Describe without writing code how you might adjust the traffic light configuration of Tasks A and B by introducing a road pressure plate (a device that signals to the system that a vehicle is waiting at the traffic signal for a change in direction). What might be needed to adjust the hardware circuit? What might be needed in the software to support this input signal? How might the traffic signal operational loop be modified?

Answer2) Introducing a pressure plate at the direction-change lane in a traffic signal system can significantly improve traffic flow efficiency. The pressure plate is designed to detect the presence of vehicles waiting for a green signal in the direction-change lane by measuring pressure above a defined threshold. Once a valid pressure is detected, the system can trigger the green light for the direction-change lane, ensuring it activates only when necessary. This approach prevents unnecessary delays and optimizes signal transitions based on real-time traffic demand.

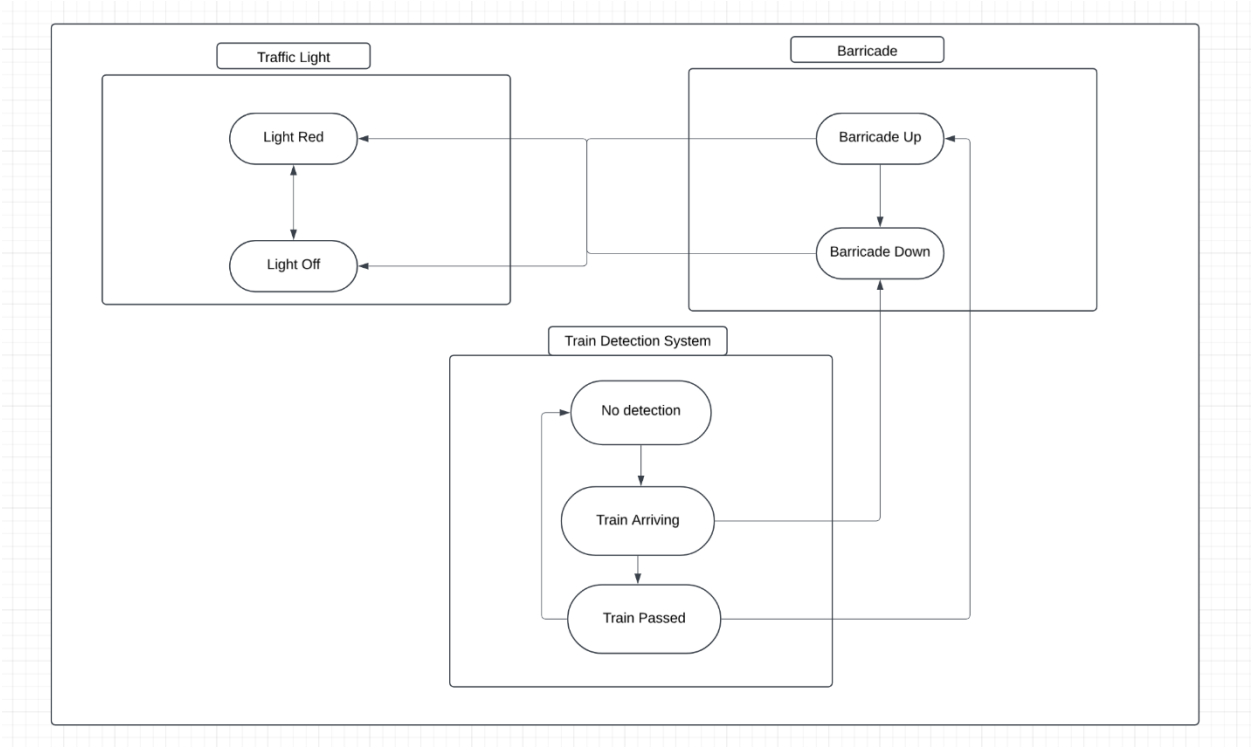
From a hardware perspective, the system requires the integration of a pressure plate sensor capable of detecting vehicle weight accurately. A signal processing device is needed to interpret the pressure readings and ensure that only signals above the threshold trigger the light. To manage the timing and sequencing of lights effectively, a timer module is included in the circuit. This module introduces delays, allowing other lights at the intersection to complete their cycles safely before switching the direction-change lane to green. The circuit controlling the lights must also be modified to incorporate the pressure plate's input as a condition for activating the green light. Additionally, fail-safe mechanisms must be implemented to ensure the traffic light operates normally in case of a sensor failure.

In terms of the operational logic, the pressure plate introduces an event-driven transition to the system. When the plate detects a vehicle, it interrupts the default traffic light sequence and initiates a special loop for the direction-change lane. The system does not immediately turn the light green upon detection; instead, a timer enforces a delay to allow other lights to complete their transitions. Once the green light is activated, it remains on for a predetermined duration or until the pressure plate no longer detects a vehicle, indicating the lane is clear. After the green light turns off, the system seamlessly returns to the default operational loop, resuming the regular traffic flow sequence.

This approach ensures a more dynamic and responsive traffic light system. By tying the direction-change green light activation to real-time vehicle presence, it reduces idle times and improves overall traffic efficiency. The use of a timer and carefully structured logic also maintains safety and prevents conflicts in signal transitions.

Question 3) Consider a problem solution where illuminating a light/LED would be useful. Design a different circuit that could be used and describe (not code) the software rules and flow that would be necessary to deliver that solution.

Answer 3)



The above system is a diagram of railway crossing, where the movement of barricade controls the light turning red and off, when the train detect system mostly laid on the railway track at a safe distance from the railway track, the barricade are triggered to go down with the changing the light to go red, as t lets the car at a certain distance know about the train arriving and for them to slow down, the barricade stays down until the entire train is passed which is detected my system to let the barricade go up again and for the signal to go off safe for the trains to pass.