Assignment 2 COMP2111 13s1
Traffic Around the Hotel

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Contents

1 Introduction

The project is designed for the local council to fix the traffic light management system that is currently used around the Hotel.

The aim is to design a system which will guarantee the following properties:

Safety: Traffic is safe around the hotel, that is, no two conflicting lights are green at the same time. In fact, a stronger form is required: before one of set of conflicting lights can turn green, all the others need to be red.

Fairness: Traffic management aspires to be fair in the sense that, if a light has been requested to become green (by a pedestrian pushing a button or by a car stopping on the induction coil), then no conflicting light can become green twice without becoming green.1

Flow: If a light has been requested to become green (by a pedestrian pushing a button or by a car stopping on the induction coil), then it will eventually become green.

2 Problem Statement: Entity Representation and Requirements

2.1 Hotel Structure Representation

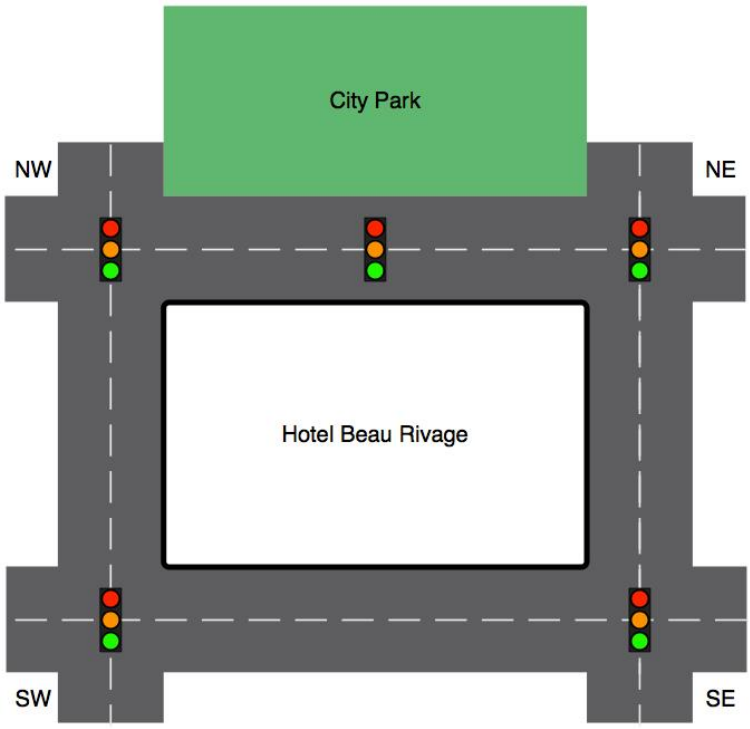

Figure 1: Hotel Structure

As shown in the diagram the structure representation of the traffic facilities around the hotel will be the following:

Table 1: Table of Hotel Traffic Entity Representation

Type	Name	Level First Introduced	Short Description
Intersection	NW	Abstract Model	The conjunction on the top-left of the diagram.
Intersection	SW	Abstract Model	The conjunction on the bottom-left of the diagram.
Intersection	NE	Abstract Model	The conjunction on the top-right of the diagram.
Intersection	SE	Abstract Model	The conjunction on the bottom-right of the diagram
Intersection	PARK	Abstract Model	The conjunction on the center-top of the diagram.
Direction	NORTHSOUTH	Abstract Model	The "vertical" direction of the diagram
Direction	EASTWEST	Abstract Model	The "horizontal" direction of the diagram
Relation	Road	Emergency	A relation which tell every other intersection include itself, which are on the same road with this intersection. For example, if input (NW, NORTHSOUTH) the set of intersections that mapped to this ordered pair, will be NW, SW
COLOR	RED	Abstract Model	The red color.
COLOR	GREEN	Abstract Model	The green color.
COLOR	AMBER	Abstract Model	The amber color.
Relation	nextColor	Abstract Model	Tell how the color cycle should change, for example the nextColor of RED should be GREEN, nextColor of GREEN should AMBER, nextColor of AMBER should be RED.

2.1.1 Overall Implementation Strategy

In order to simplify the problem, the system implement separate events for different condition, e.g. there is a event, which will change the traffic light for intersection, which has no sensors triggered, and another event which change color for intersections, which has sensor triggered.

2.2 Task 1: Abstract

2.2.1 Requirements

Requirements	Function
Change color of lights	The system should be change color of traffic light and pedestrian light of each direction and intersection.
Safety Feature 1	For every intersection, if the traffic light on direction one is GREEN or AMBER, it implies the traffic light on the other direction must be RED.
Safety Feature 2	For every intersection, if the traffic light on direction one is GREEN or AMBER, it implies the pedestrian light on the other direction must be RED.
Safety Feature 3	For every intersection, and for both the traffic light and pedestrian light, the light on two different direction can only be RED at the same time.
Safety Feature 4	For every intersection, pedestrian light can only turn GREEN, if the traffic light on the same direction is GREEN.

2.2.2 Implementation Strategy

For the ease of modeling, the system treat the Intersection PARK, which doesn't have traffic light on the NORTHSOUTH direction, same as every other direction. = This implies that the whole process for change of color for pedestrian light and traffic can be modeled with two events. since every intersection are treated the same.

For the purpose of Emergency, the system also have a set of events which will initiate a safe condition for the traffic.

Events	Usage
changeTrafficCycle	The event which will change the color of all intersection. The event does the same thing as all 3 events: • changeTrafficToRED • changeTrafficToAMBER • changeTrafficToGREEN combined together.
changeTrafficToRED	Set the color of light(traffic) to RED, A separate event used to ensure the ease of modeling in later refinements when sensors are added.
changeTrafficToAMBER	Set the light(traffic) to AMBER, A separate event used to ensure the ease of modeling in later refinements when sensors are added.
changeTrafficToGREEN	Set the light(traffic) to GREEN, A separate event used to ensure the ease of modeling in later refinements when sensors are added.
changePedToGreen	Set the light(pedestrian) to GREEN.
changePedToRed	Set the light(pedestrian) to GREEN.
roadToGreen	Set the light(traffic) on the road to GREEN, used for later emergency refinement.
roadToOPPOSITERed	Set all lights to RED, used for later emergency refinement.

2.3 Task 2: Add Sensor

2.3.1 Requirements

Requirements	Function
Detect Sensor	The system should be able to detect if a sensor is triggered, and register status accordingly.
Fairness Feature 1	Sensor can not be trigger if the light on the direction triggered at a intersection is not RED.
Fairness Feature 2	If a intersection has a sensor triggered, then the direction at the intersection become GREEN mush be the same as the direction triggered.
Fairness Feature 3	Sensor can only be triggered once. This implies once a sensor is triggered it can't be triggered again until the color on this intersection becomes GREEN.
Fairness Feature 4	Sensor only valid for one time. This implies once the light become GREEN, the sensor must be set to be not triggered state.

2.3.2 Implementation

Event	Usage
changeTrafficCycle	Used when trigger is not set.
changeTrafficToRED	Used when trigger is set.
changeTrafficToAMBER	Used when triggered is set.
changeTrafficToGREEN	Used when triggered is set.
changePedToGreen	Used both when triggered is set and not set.
changePedToRed	Used both when triggered is set and not set.
roadToGreen	No further change at this level.
roadToOPPOSITERed	No further change at this level.
triggerTrafficCoil	Trigger the traffic coil on a direction at a intersection.
triggerPedSensor	Trigger the pedestrian sensor on a direction at a intersection.

At this level, when sensors on both direction at a intersection the fairness of FIRST PRESS FIRST TURN TO GREEN is not guaranteed to happen.

Also this level weak fairness is required for events, since the B-Language can't guarantee the flow of system, it is not clearly indicated. However the flow of system is improved by setting a more deterministic model(separate turn traffic light system).

2.4 Task 3: Add Logic

2.4.1 Requirements

Requirements	Function
Fairness Feature 1	This refinement ensure the sensor that is TRIGGERED FIRST will become GREEN FIRST.

2.4.2 Implementation

Fairness Feature 1 is ensured by introduce some new variables, which priorities the sensor at each intersection.

Event	Usage
changeTrafficCycle	No further change at this level.
changeTrafficToRED	No further change at this level.
changeTrafficToAMBER	No further change at this level.
changeTrafficToGREEN PedSingleTrigger	Turn color of the traffic light when there is only one sensor pressed.
changeTrafficToGREEN PedDoubleTrigger	Turn color of the traffic light on the direction is more prioritized when both direction is pressed.
changeTrafficToGREEN TrafficSingleTrigger	Turn color of the traffic light when there is only one sensor pressed.
changeTrafficToGREEN TrafficDoubleTrigger	Turn color of the traffic light on the direction is more prioritized when both direction is pressed.
changePedToGreen	Restore priority
changePedToRed	No further change at this level.
roadToGreen	No further change at this level.
roadToOPPOSITERed	No further change at this level.
triggerTrafficCoil NoPriorityUpdate	Trigger sensor without change priority at the intersection. In case, the other sensor is pressed, but not yet changed to GREEN.
triggerTrafficCoil PriorityUpdate	Trigger sensor with priority update.
triggerPedSensor NoPriorityUpdate	Trigger sensor without change priority at the intersection. In case, the other sensor is pressed, but not yet changed to GREEN.
triggerPedSensor PriorityUpdate	Trigger sensor with priority update.

The system is still lack of one Fairness feature, if traffic light on directionA is triggered, and the pedestrian on the direction opposite directionA is triggered. The SPEC OF THE ASSIGNMENT has not specified which one should be changed first.

In fact, this system can be tricked into situation due to the conflicting priority on two direction at the same intersection to become dysfunctional with respect to the fairness established.

2.5 Task 4: Emergencies

2.5.1 Requirements

Requirements	Function
Emergency	Every other event should give way to emergency.

2.5.2 Implementation

Event	Usage
changeTrafficCycle	Function only when no emergency happen.
changeTrafficToRED	Function only when no emergency happen.
changeTrafficToAMBER	Function only when no emergency happen.
changeTrafficToGREEN PedSingleTrigger	Function only when no emergency happen.
changeTrafficToGREEN PedDoubleTrigger	Function only when no emergency happen.
changeTrafficToGREEN TrafficSingleTrigger	Function only when no emergency happen.
changeTrafficToGREEN TrafficDoubleTrigger	Function only when no emergency happen.
changePedToGreen	Function only when no emergency happen.
changePedToRed	Function only when no emergency happen.
triggerTrafficCoil	Function only when no emergency happen.
triggerPedSensor	Function only when no emergency happen.
InitEmergency	Initiate a safe situation, and set the road ,which is request to be ready for emergency.
SetEmergency	Turn every light on the same direction to be green, and shut off the emergency alert.

3 Comments: Undischarged POs and Development Related Issue

3.1 Task 1: Abstract Model

Event	PROBLEM
changeTrafficCycle	INV3 The problem is same as changeTrafficToGreen.
changeTrafficCycle	INV4 The problem is same as changeTrafficToGreen.
changeTrafficToGreen	The INV3 should be covered by guard trafficLight(intersection `|->` otherDirection(direction)) = RED
changeTrafficToGreen	The INV4 should be covered by guard pedLight(intersection `|->` otherDirection(direction)) = RED
roadToGreen	The event is a deterministic event, it only fires when under specified situation. The possible reasons of why it is not discharged is: • System is too big for it to pick up all invariants • Rodin is worrying about the assigned values within the domain or not, this are ensured by the guard.

3.1.1 Problems Encountered With Rodin Platform

Rodin is incapable of picking up all problems as the system grows bigger. For instance, when all of the context file were merged together at the start of the modeling, Rodin failed every implementation, however, after separating them into different context files, they became provable. During the development, the animator ProB was updated, and after the update it gives file exception errors, when not supposed to. this was fixed by downgrading the system.

3.2 Lessons Learnt & Further Development

- always make simple context
- have separate events for different requirements
- don't update Rodin Platform.

3.2.1 Further Development Strategy

Implement the Logic flaw that was specified at the end of the AddLogic Section, which was not specified in the SPEC of the assignment.

Use a better strategy to implement the Light representation, Rodin Platform isn't very good at dealing with proofs involve ordered pairs.

A Reference

Assignment 2 COMP2111 13s1
Traffic Around the Hotel
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