Hong Kong Baptist University
Department of Computer Science
COMP4107 – Software Design, Development and Testing
(2019-20 Semester 2)

Term Project
Project Specification
(Document Version: 1.1)

This is a project, where students will work in groups to design, develop and test the Parking Control System (***PCS***), which is used for controlling different hardware components of a parking lot. This document provides you the background information about the project (see *Section A* below). The project is divided into six phases, where basic information about these phases is provided in *Section B*.

A. Background of PCS

PCS is a software system that controls different hardware components of a parking lot, for example, the entrance and exit gates, ticket dispatcher, pay machines, ticket collector, motion sensors, and vacancy display.

The main objective of this project is to implement PCS, and to build emulators for the hardware components to simulate communication between PCS and the hardware components. The following paragraphs explain the physical layout of the parking lot, the normal operations of the parking lot, and how PCS interacts with these hardware components.

I. Physical Layout of the Parking Lot

The parking lot has only one entrance and one exit. It has a few floors, and each floor has a fixed number of parking spaces. There are two ramps connecting between floors, one for going up, and one for going down. Each ramp is equipped with a motion sensor that detects cars driving through. There is a display at the entrance of the parking lot showing the number of available parking spaces of each floor. Also, there are a few pay machines somewhere around the parking lot for drivers to pay for the parking.

II. Normal Operations of the Parking Lot

In the parking lot, there are a few operations, as described below.

1. ***Entering the Parking Lot***
   When a driver enters the parking lot with the car, the driver stops at the entrance, press the button on the *ticket dispatcher*. The dispatcher would then print a ticket, and dispatching it to the driver. After the driver collects the ticket from the dispatcher, the *entrance gate* would be opened, allowing the driver to drive into the parking lot. Note that the ticket is equipped with a magnetic strip which stores the time when the car enters the parking lot. The time is also printed on the ticket for the driver's reference.

2. ***Driving Around in the Parking Lot***
   After entering into the parking lot, drivers can drive around different floors looking for a parking space to park. When going from one floor to another, the movement would be detected by the *motion sensors*, which would signal PCS, allowing PCS to calculate the number of available parking spaces of each floor.

3. ***Paying for the Parking***
   A driver should make payment at one of the *pay machines* before leaving the parking lot. At the pay machine, the driver should first insert the ticket into the ticket reader, and the display would show the parking fee. The driver would then make the payment using *Octopus card*. Once the payment is made, the pay machine would return the ticket to the driver with the amount of parking fee, the current time, and the pay machine ID printed on the ticket. The same information would also be stored in the magnetic strip of the ticket. The driver would then collect the ticket and proceed to the parking exit.

4. ***Leaving the Parking Lot***
   To leave the parking lot, the driver should drive to the parking exit and insert the ticket into the ticket collector (assuming payment has been made). The ticket collector would validate the ticket, and opens the exit gate if the ticket is successfully validated. If the ticket is not validated, an alarm would ring, and the parking lot staff would come and handle.

III. Hardware Components

PCS manages a few hardware components. They are briefly described below.

1. ***Entrance and Exit Gates***
   The entrance and exit gates are the horizontal bar that stops cars from proceeding before they are allowed to do so. They receive signals from PCS for opening or closing the gates. It normally takes a few seconds for its opening or closing. When the gate is completely opened/closed (depends on the instruction from PCS), it will send a signal to notify PCS. Note that PCS assumes that there is only one entrance and one exit in the system.

2. ***Ticket Dispatcher***
   The ticket dispatcher is located at the entrance of the parking lot. It has a button, which drivers would press, and a ticket would be issued. When the button is pressed, the dispatcher would send a message to PCS (the *ticket request message*), and PCS would send the *entrance information* to the dispatcher, which includes the *ticket number* and the *entering time*. The dispatcher would then store this entrance information to the ticket's magnetic strip. The same information is also printed on the ticket for the driver's reference. The driver then should remove the ticket from the dispatcher, and the dispatcher would send a message to PCS (the *ticket collected message*), and then PCS would open the entrance gate by sending it a signal. After some preset timeout, PCS would send another signal to the entrance gate for closing it.

3. ***Pay Machines***
   The parking lot has a few pay machines around the parking lot area. When a driver is about to leave, the driver would insert the ticket into a pay machine. The pay machine would read the entrance information from the magnetic strip. The entrance information would then be sent to PCS for the calculation of the parking fee. After the calculation, PCS would send the amount charged for the parking to the pay machine, and the pay machine would display the amount to the driver. The driver would then make the payment using Octopus card. After the payment is made, the pay machine would send a message to PCS indicating that the driver has paid for the ticket. PCS would then send the *exit information* to the pay machine, which includes the *amount of the parking fee* and the *exit time*. The pay machine would then store this exit information to the ticket's magnetic strip. The same information is also printed on the ticket for the driver's reference. Finally, the driver would remove the ticket from the pay machine.

4. ***Ticket Collector***
   After making payment at a pay machine, the driver drives the car to the exit gate, and stop at the ticket collector. The driver would insert the ticket into the ticket collector, and the collector would read the entrance and exit information from the ticket. The collector would send the entrance and exit information to PCS for validation.

   If the validation is successful, PCS would send a *positive acknowledgement* to the collector. PCS would also send a signal to the exit gate, and the exit gate would open to allow the driver to leave.

   However, if the validation is unsuccessful (e.g., the driver has not paid at a pay machine yet, or the exit time is over a preset timeout), PCS would send a *negative acknowledgement* to the collector, and the collector would ring the alarm. The parking lot staff would come out and resolve the problem. When the problem is resolved, the staff would press the *manual override* button (requires a key to enable) on the collector. The collector would stop the alarm and send a signal to PCS, and PCS would open the exit gate by sending a signal to it. After some preset timeout, PCS would send another signal to the exit gate for closing it.

5. ***Motion Sensors***
   As previously mentioned, there are two ramps connecting between adjacent floors (one for going up, and one for going down), and each ramp is equipped with a motion sensor. The motion sensors would send a signal to PCS whenever it detects a car driving through. This allows PCS to calculate the number of available parking spaces of each floor, so that it can update the vacancy display at the entrance of the parking lot.

6. ***Vacancy Display***
   The vacancy display is located at the entrance of the parking lot. It shows the number of available parking spaces of each floor. Note that it receives such information from PCS, and is updated immediately.

B. Due Dates and Mark Distribution for the Project Phases

This Group Project is worth 80% of this course. It is divided into six phases. Detailed information about these phases will be provided in due course. The tentative deadlines and the mark distribution for them are provided below:

- ***Phase 1 – System Analysis & Design***
  Marks: 15% of the project
  Deadline: Friday Mar. 13, 2020 (23:59)

- ***Phase 2 – Implementation***
  Marks: 50% of the project
  Deadline: Sunday Apr. 19, 2020 (23:59)

- ***Phase 3 – Test Plan***
  Marks: 10% of the project
  Deadline: Wednesday Apr. 22, 2020 (23:59)

- ***Phase 4 – Test Report***
  Marks: 10% of the project
  Date: Monday Apr. 27, 2020 (23:59)

- ***Phase 5 – Presentation + Demonstration***
  Marks: 0% of the project
  Date: Apr. 29-30, 2020

- ***Phase 6 – Individual Report***
  Marks: 15% of the project
  Date: Monday May 4, 2020 (23:59)

Please note that *Phase 5* – the *Presentation and Demonstration* – is scheduled to take place *outside* of our regular lecture meetings on Apr. 29-30 (Wednesday-Thursday). All students ***must attend*** the presentation of their own group. Failing to do so will face *heavy penalty* on their over project mark. Please reserve your time (tentatively 10:00am-5:00pm) for this.

Document Revision History

Rev.	*Date*	*Description*
1	Mar. 4, 2020	Initial Release
1.1	Mar. 6, 2020	• Phase 1 deadline changed • Descriptions for Hardware Components revised i. Gates – Signals for the completion of opening or closing of gate added ii. Dispatcher – removal of ticket and PCS' handling added iii. Pay machine – driver's removal of tickets added iv. Collector – Manual override button would stop the alarm
1.2	Mar. 9, 2020	• Descriptions for Dispatcher and Collector updated: after some timeout, PCS would send another signal to close the gate