HANOI UNIVERSITY OF SCIENCE AND TECHNOLOGY

School of Information and communications technology

Software Design Document

Version 1.0

EcoBikeRental (EBR)

Subject: ITSS Software Development

Group 03

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Hanoi, November, 2021

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1 Introduction

1.1 Objective

This Software Design Document (SDD) is created to describe the technical details of the bike management system, intended to supplement maintainers or future innovators of the high level design, as well as implementation of the current system.

1.2 Scope

The main target of this product is to automatically manage bikes in stations,as well as their customer interaction. The system will make use of a scanner for the purpose of recognizing barcodes on each bike, and from that information handles the business process, as well as correctly prompt and record different fees for each bike instance, namely standard bike, twin bike, standard e-bike, and twin e-bike.

Firstly, customers register an account on EcoBikeRental application, fill in appropriate information entries, then allow permissions where needed of the application, and finally set up a working payment method to pay charges, either through linking with inter-bank or an e-wallet. Upon bootstrapping, the position of the user and the location of nearby docking stations will be visible on a map on the screen. By navigating on the map, as well as searching on the dock list, the customer can see available docks there currently, and information on each bike. If the customer finds a suitable bike for his/her need, by scanning the barcode on said bike, the system will proceed with the monetary procedure.

To proceed with a payment, the application will first display the scanned bike information, then ask the customer to provide a payment method. The customer is required to deposit for at least 40% of the value of the bike. Upon agreeing to the payment details, the system will deduct the said amount from the customer's chosen monetary source, and finally open the bike’s lock, and start counting used time.

During the renting period, the customer accesses relevant information of their renting on the system through the application, such as their renting bike type, current renting time, the amount to be paid, and the bike status. To return a bike, the user pushes the bike into an empty docking point of a dock, then closes the lock. The system will automatically calculate the fee, and return any remaining deposit if there is any.

The system handles the validation process, as well as control of bike locks, and display of system information. If there is an error in processing, an error will be prompt to the user..

1.3 Glossary

A.

Actor: a role played by a user or any other system that interacts with the subject.

B.

Barcode: a method of representing data in a visual, machine-readable form. Initially, barcodes represented data by varying the widths and spacings of parallel lines

C.

D.

Data: the quantities, characters, or symbols on which operations are performed by a computer, being stored and transmitted in the form of electrical signals and recorded on magnetic, optical, or mechanical recording media.

Docking station: Station that holds bikes.

Dock marker: mark of the map indicating a dock.

E.

F.

Flow of events: A sequence of events or actions within a use case.

G.

H.

I.

Information: is processed, organised and structured data.

*Input***:** Data that is sent into a system or a program to be processed and executed.

Inter-bank: A bank to pay for transactions made by the customer.

J.

Java Runtime Environment (JRE): A set of software tools, which are included for development Java applications.

L.

Locker: A system that controls the opening and closing of physical locks and interacts with applications.

M.

N.

O.

P.

Q.

R.

S.

*Software Development Kit (SDK)***:** A set of software tools that allow some applications to be created for certain software packages or other similar development platforms

System: a hardware or software system, or combination, which has components as its structure and observable share data as its behavior

Scanner: A function of the software that takes barcode as input and checks bike information to display

Standard bike: a kind of bicycle that has 01 saddle, 01 pedal, and 01 rear seat in the back

Standard e-bike: a kind of bicycle that looks like a standard bike, but has an integrated electric motor for assisting propulsion and the rental fee costs 1.5 times that of a standard bike.

T.

Twin bike: a kind of bicycle that has 02 saddle, 02 pedal, and 01 rear seat with no integrated electric motor with rental fee costs 1.5 times that of a standard bike

U.

Use case: A sequence of actions a system performs that yields an observable result of value to a particular actor.

V.

W.

X.

Y.

Z.

1.4 References

Centers for Medicare & Medicaid Services. (n.d.). *System Design Document Template.* Retrieved from Centers for Medicare & Medicaid Services: https://www.cms.gov/Research-Statistics-Data-and-Systems/CMS-Information-Technology/XLC/Downloads/SystemDesignDocument.docx

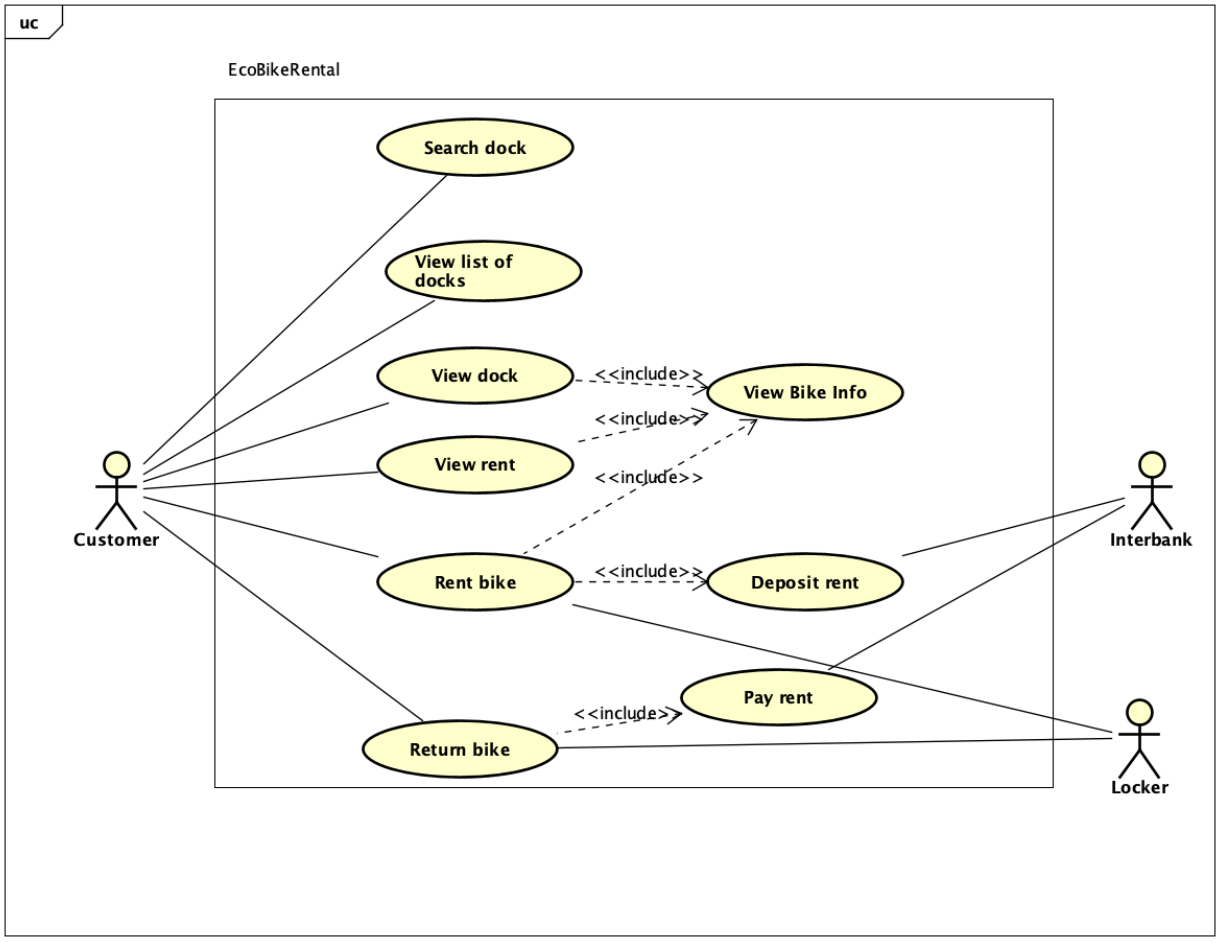
Trang, N. T. (2019, September). Problem Statement: Eco Bike Rental. Retrieved from: https://www.dropbox.com/sh/2llptvvm9atklen/AADGszPxE-JdkRrsPnaRYeO6a/CapstoneProject?dl=0&preview=EcoBikeRental-ProblemStatement-EN.pdf&subfolder_nav_tracking=1

2 Overall Description

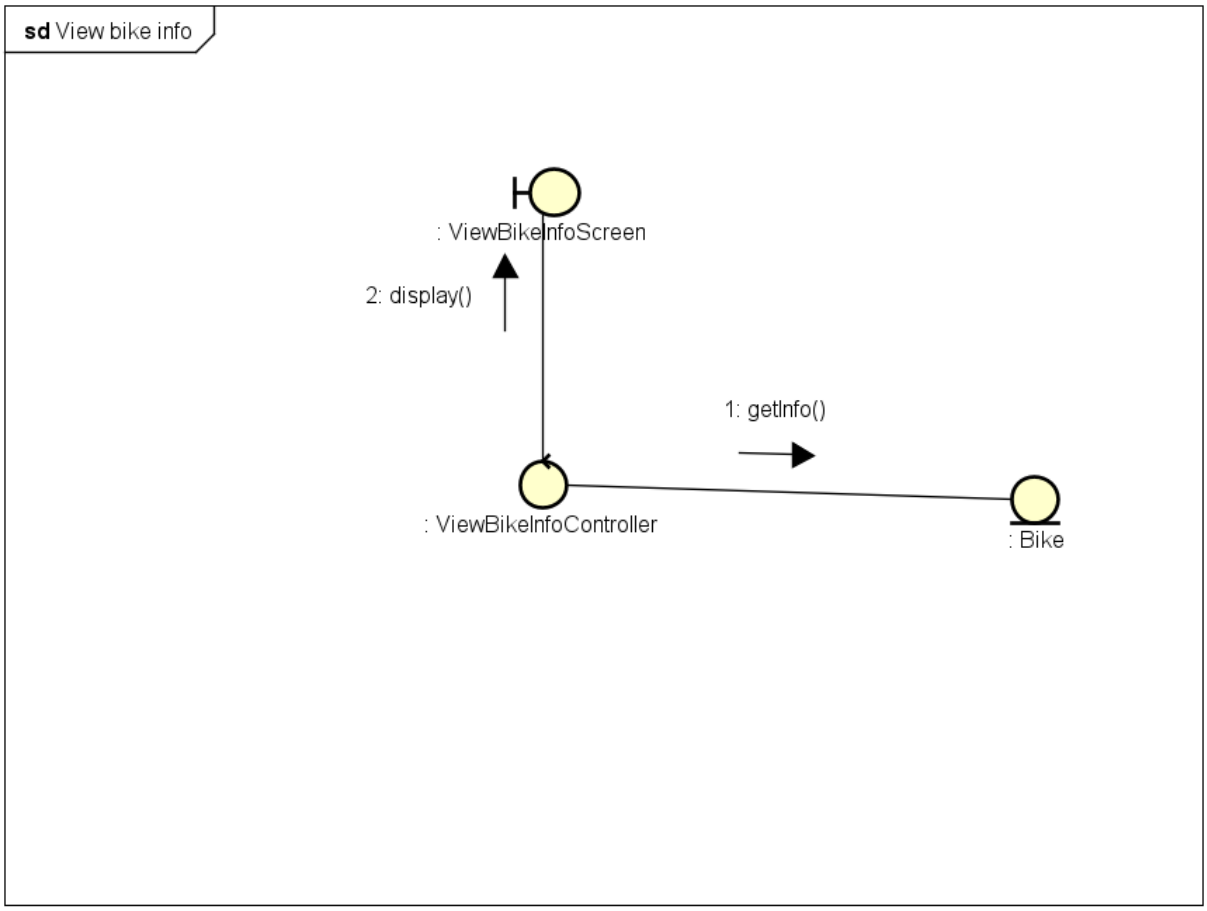
2.1 General Overview

The system is built with Java SDK to be used on multiple devices. The software will follow the client-server approach, where users will see information about bikes and docks on their devices. The requests will be sent to the server, where it will be proceeded and then sent back the result/error to the user interface. The system can also interact with outer devices and systems, namely the locker on dock stations for lock/unlocking the bikes, and the interbank API for payment processing.

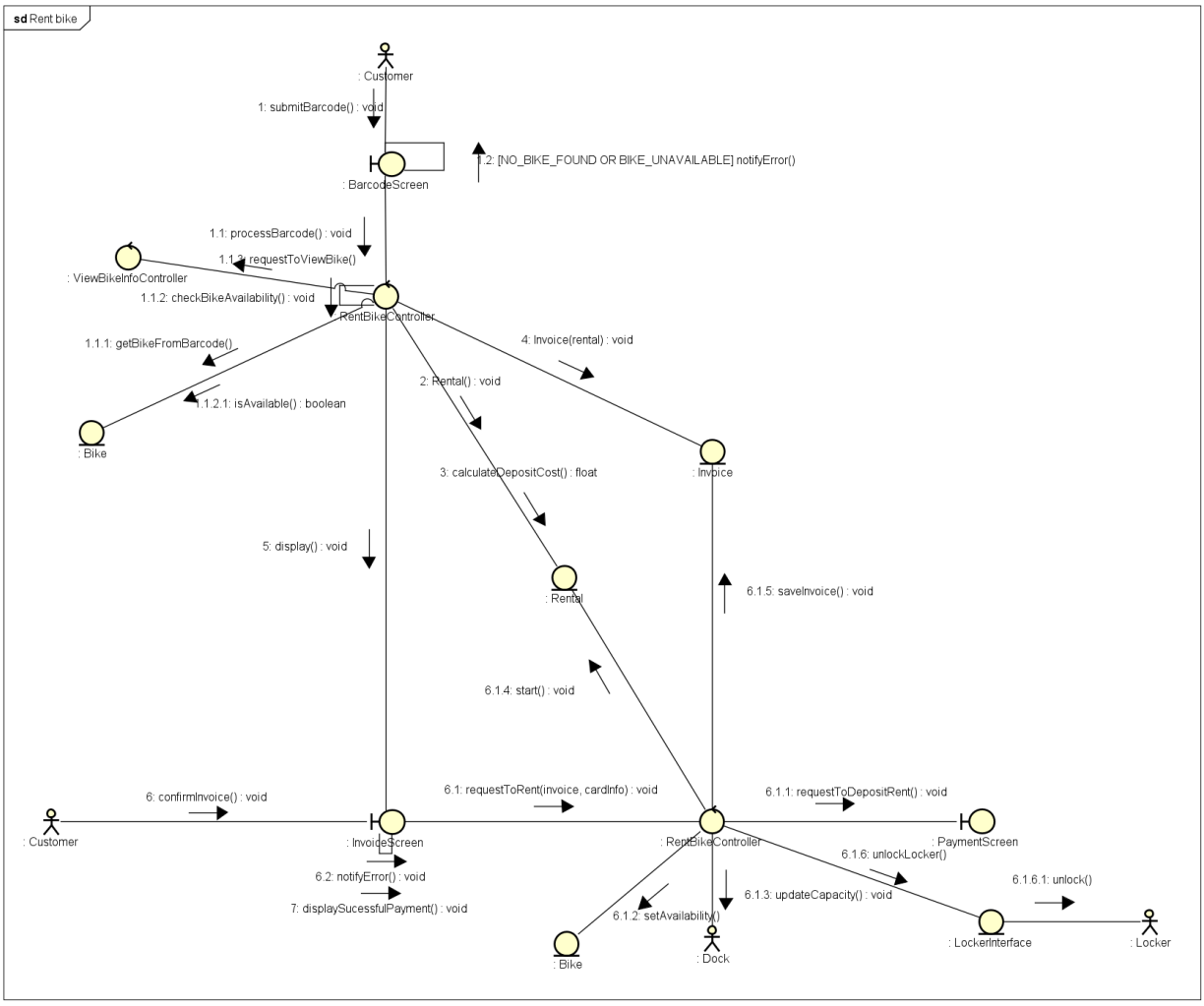
2.1.1 Use Case diagram



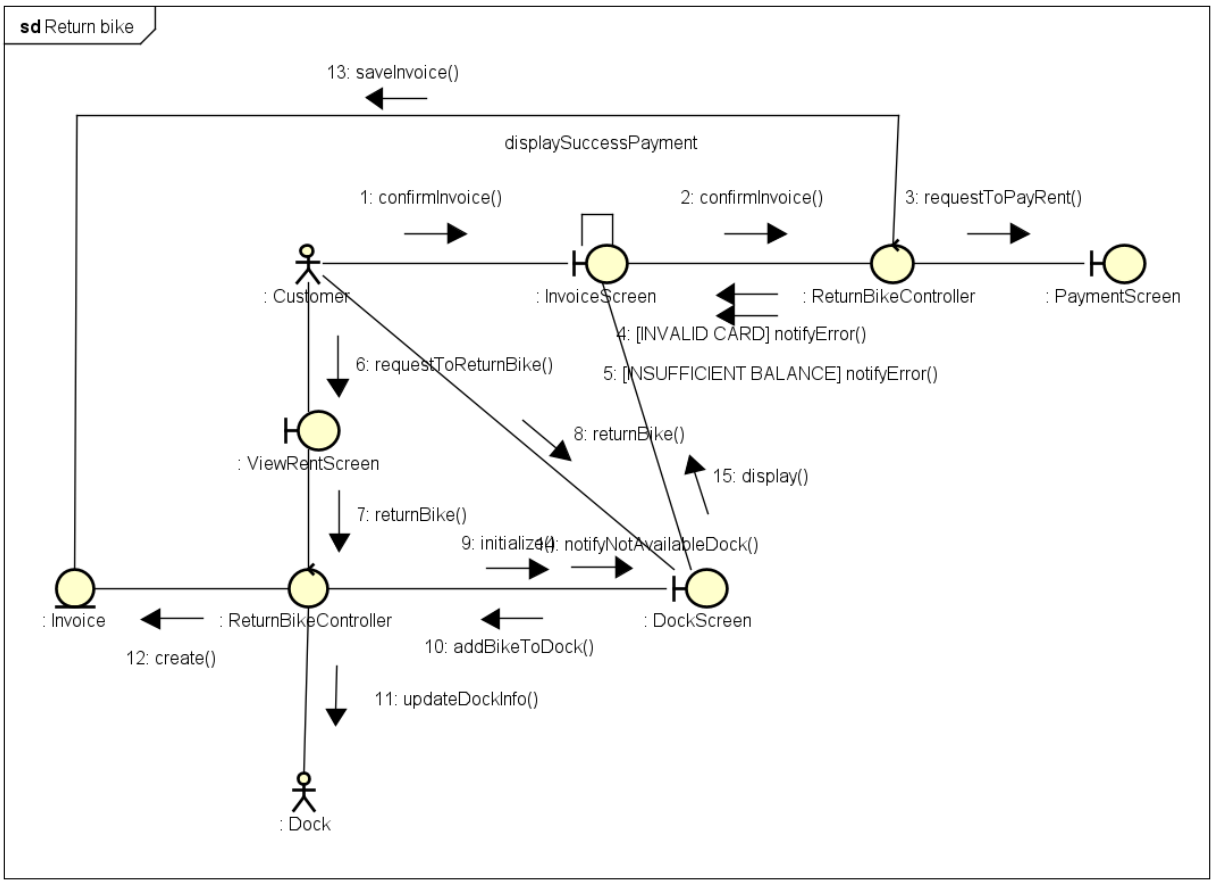
2.1.2 Use Case “View Bike Info”



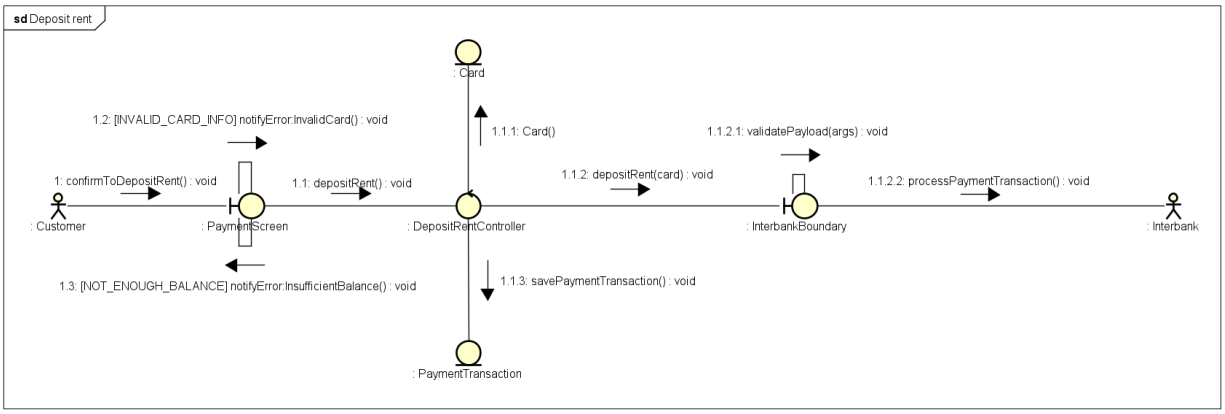
2.1.3 Use Case “Rent Bike”



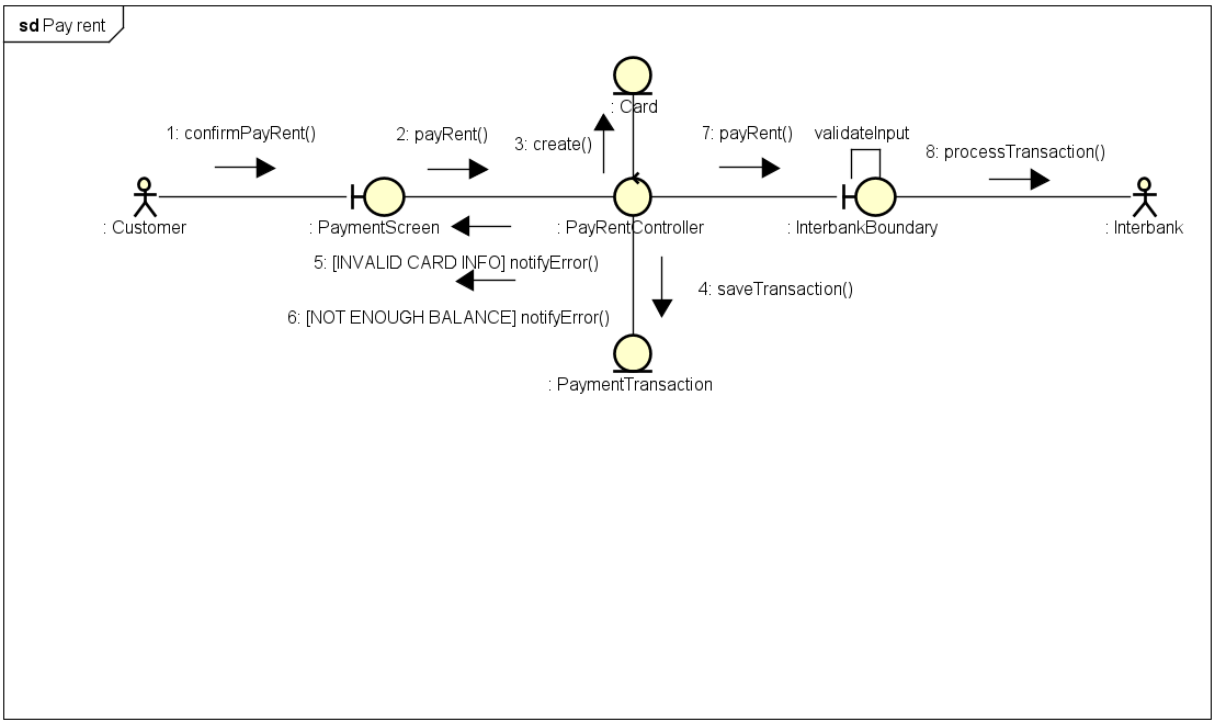
2.1.4 Use Case “Return Bike”



2.1.5 Use Case “Deposit Rent”



2.1.6 Use Case “Pay Rent”



2.2 Assumptions/Constraints/Risks

2.2.1 Assumptions

The system pre-suppose that the users have internet connection on their devices, as well as a working payment method (through interbank or e-wallet) if they want to actually rent a bike.

The device that the software will be installed in is required to have Java SDK, have at least 50MB of memory. The dock station also requires an internet connection, as well as electricity on proceeding the rent.

The user should know the basic flow of how to rent and return a bike.

Possible changes in the future will mostly be related to the display of the software to the user interface.

2.2.2 Constraints

<Describe any global limitations or constraints that have a significant impact on the design of the system's hardware, software and/or communications, and describe the associated impact. Such constraints may be imposed by any of the following (the list is not exhaustive):

- *Hardware or software environment:* the software needs to run on JAVA Virtual Machine, ideally takes small enough memory and network bandwidth to be usable on mobile devices.
- *End-user environment:* Users are not required to know too much about underlying system
- *Availability or volatility of resources:* The software should run relatively stable, and calculate the rent time correctly.
- *Standards compliance:* The system should not collect customer information without consent
- *Interoperability requirements:* The system can read user input in ascii
- *Interface/protocol requirements:* The network request should take at most 1 second
- *Licensing requirements: None*
- *Data repository and distribution requirements:* Include business flow and basic instruction on how to use and install the system.
- *Security requirements:* The software should have validation on user input.
- *Memory or other capacity limitations:* Should take less than 50MB to fit on a mobile device.
- *Performance requirements:* The system is quick to navigate.
- *Network communications:* Require regular network communication.

2.2.3 Risks

The system design is quite simple, and might not scale well if business flow changes, or there is a change in fee calculation. With current flow in mind, we should keep the current design and renovate it later if such a need arise.

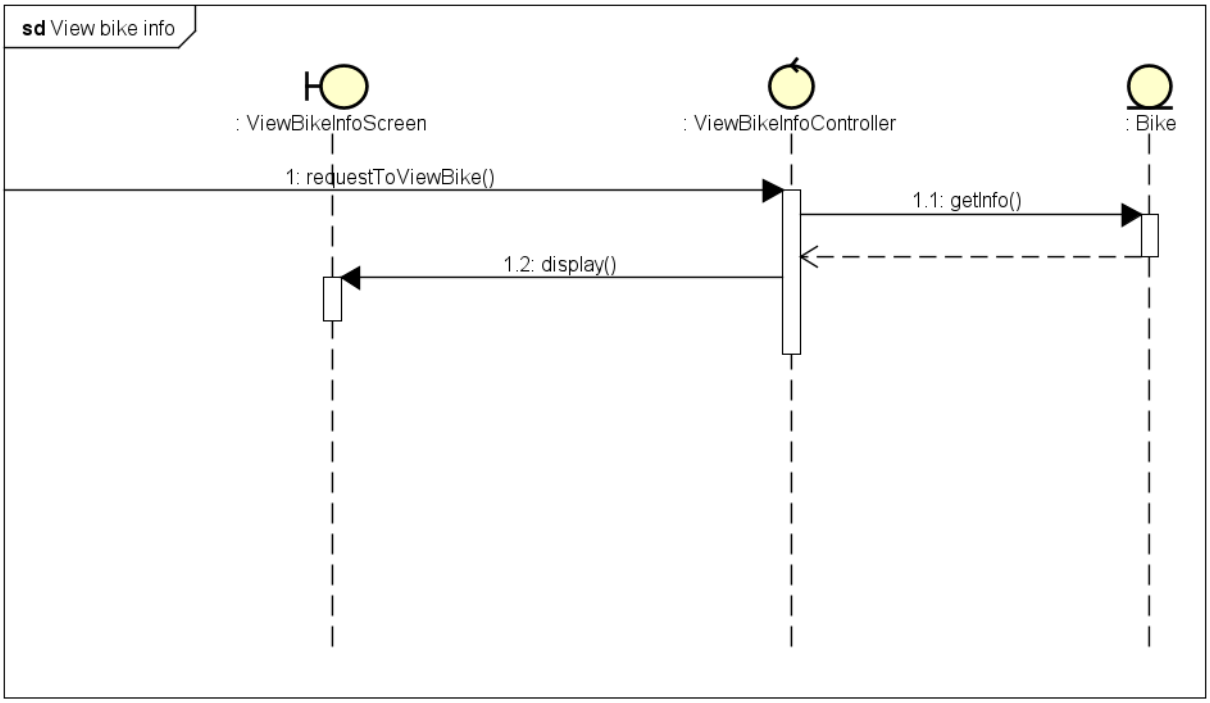
3 System Architecture and Architecture Design

3.1 Architectural Patterns

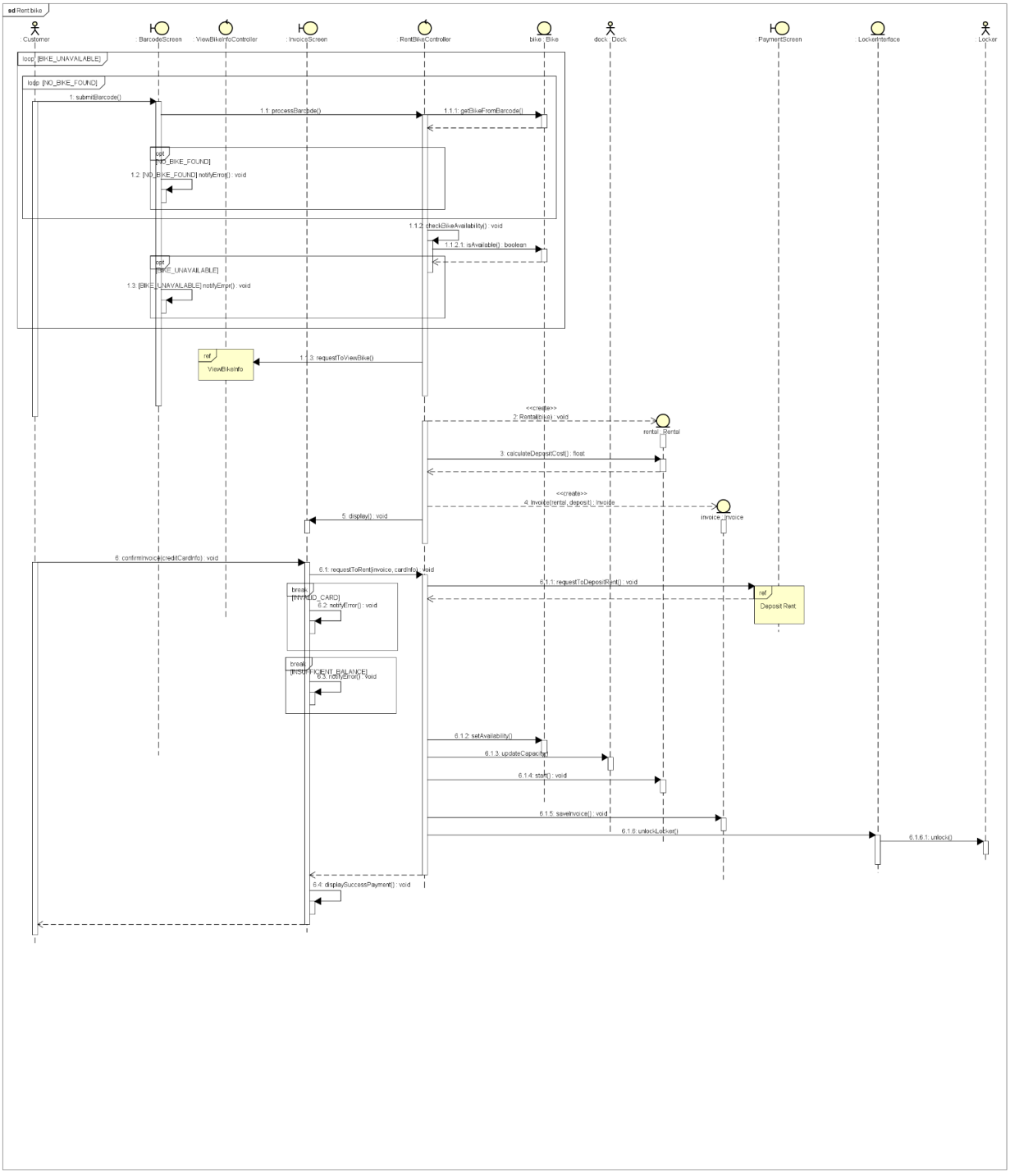
<Specify and briefly describe the chosen architectural patterns and the reasons why they were chosen>

3.2 Interaction Diagrams

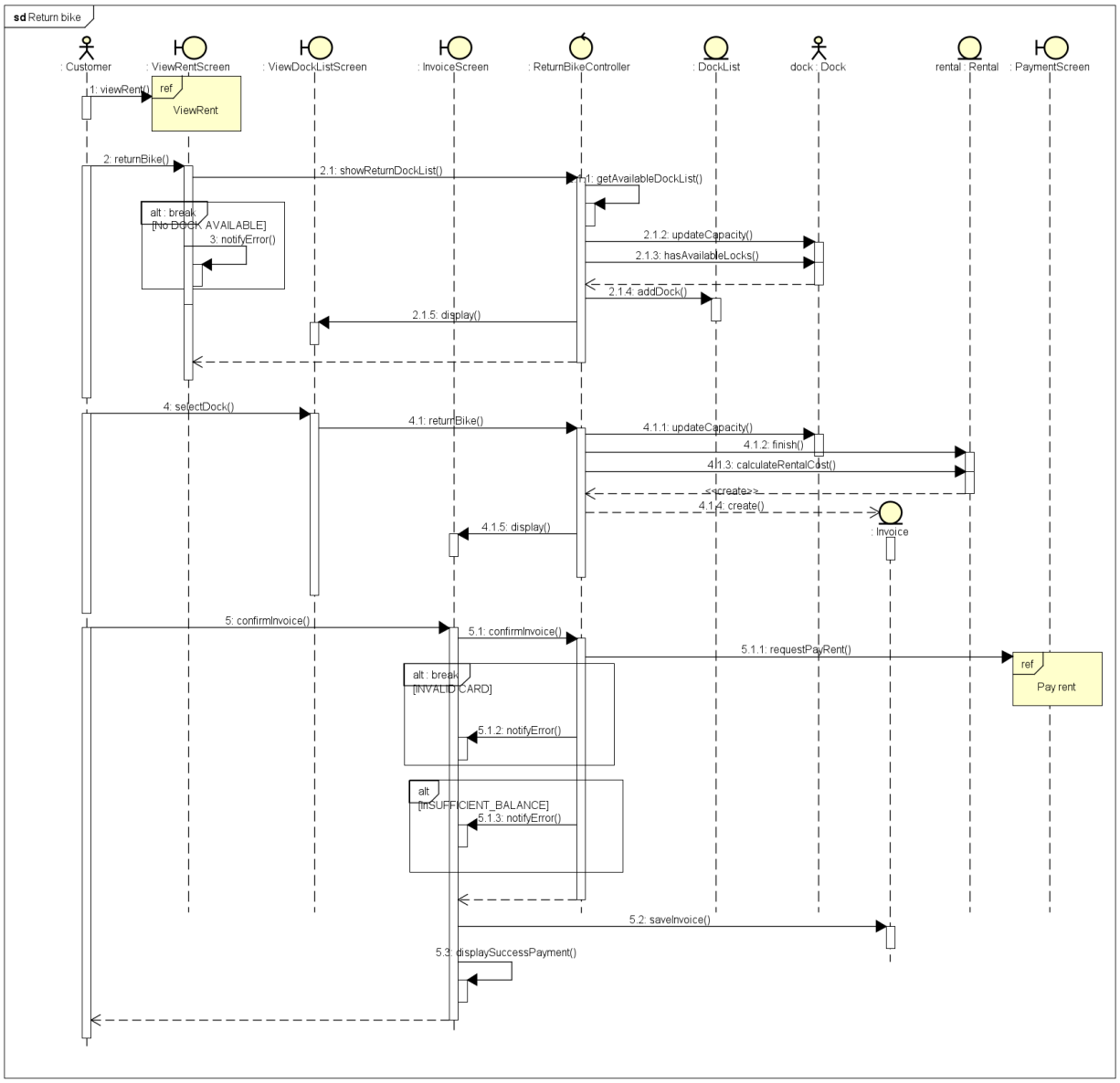
3.2.1 View Bike Info



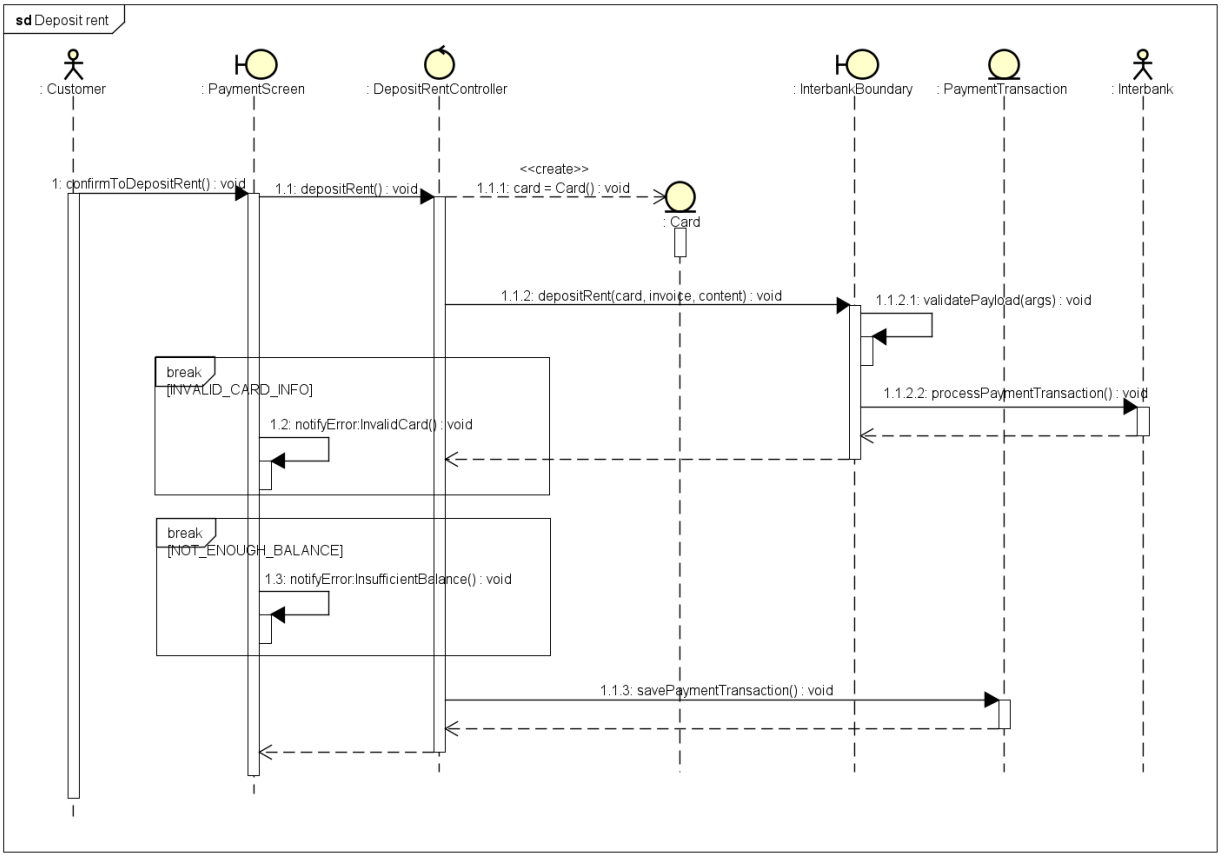
3.2.2 Rent Bike



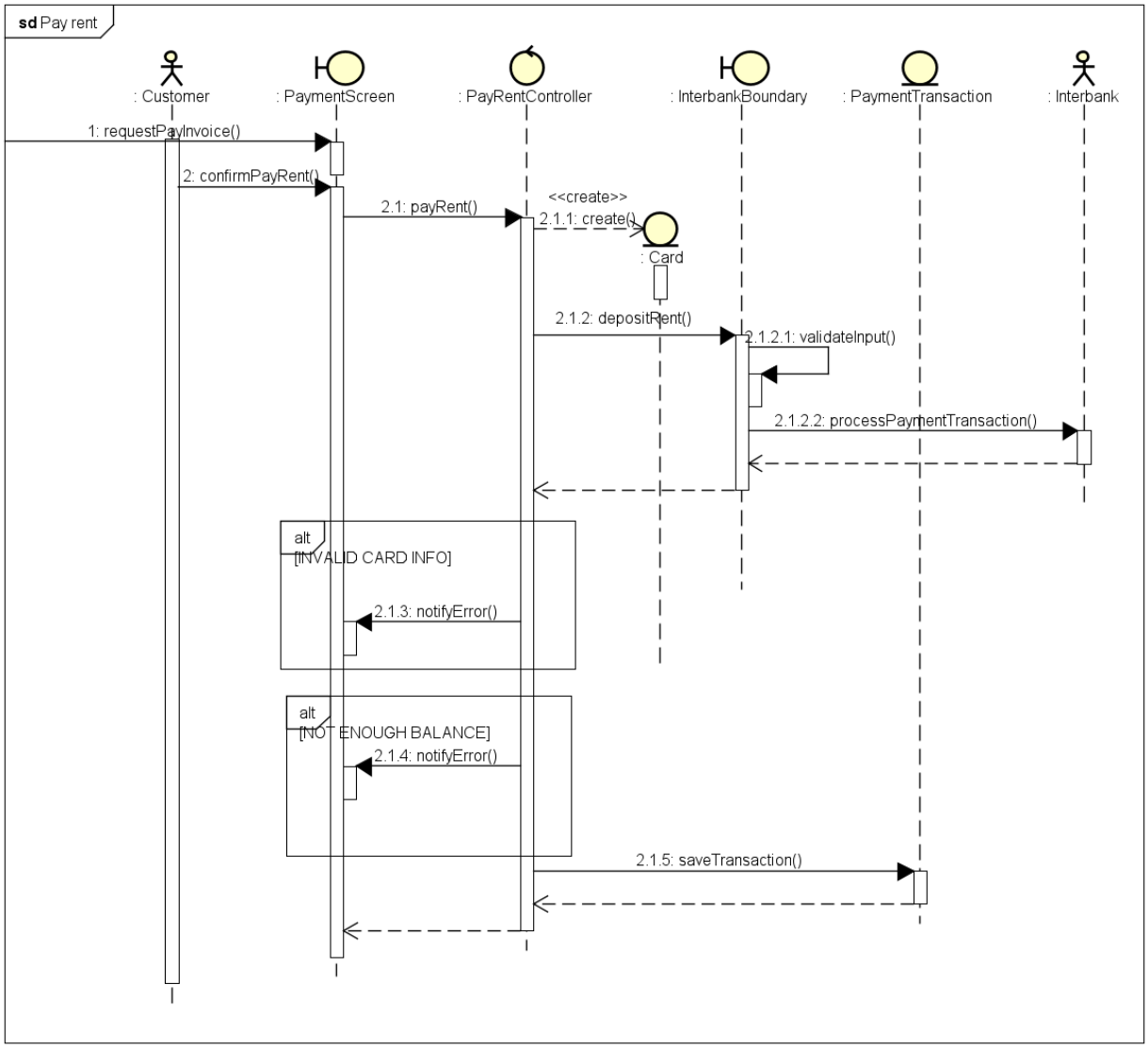
3.2.3 Return Bike



3.2.4 Deposit Rent

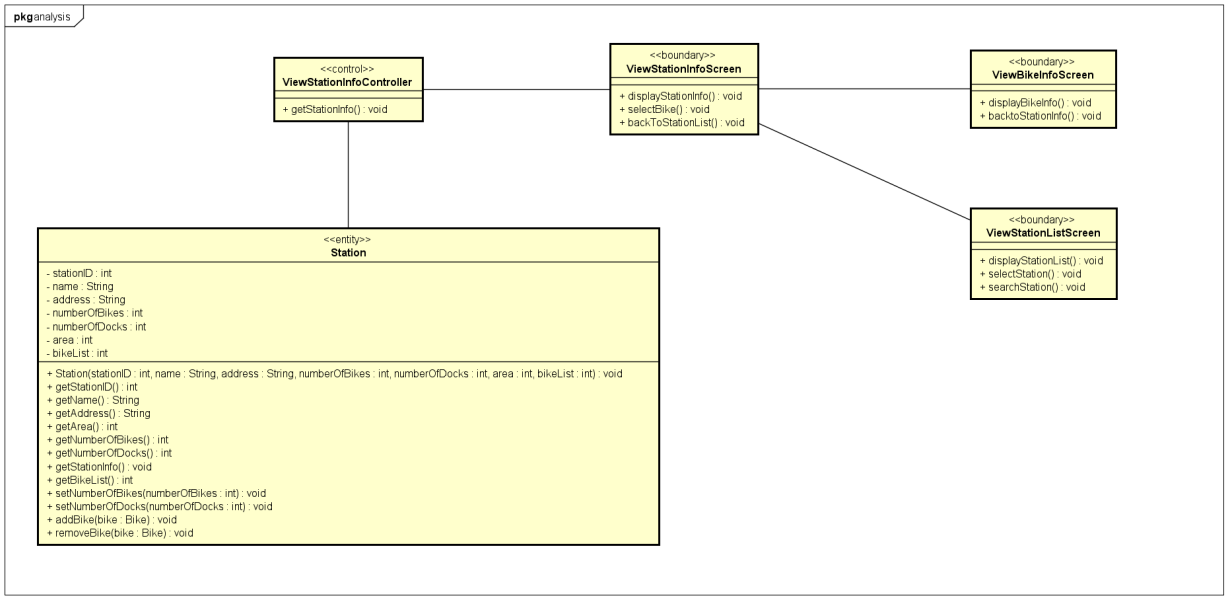


3.2.5 Pay Rent

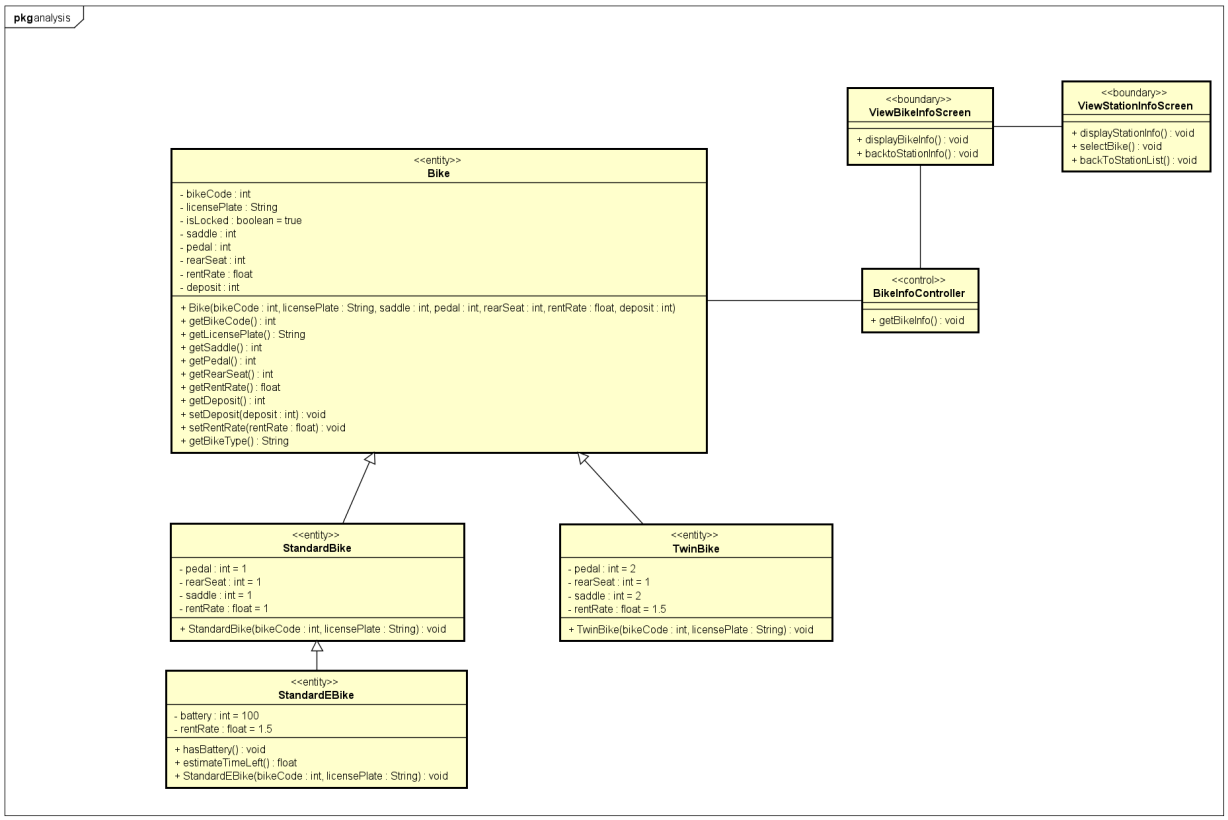

sd Pay rent
: Customer
: PaymentScreen
: PayRentController
: InterbankBoundary
: PaymentTransaction
: Interbank
1: requestPayInvoice()
2: confirmPayRent()
2.1: payRent()
<<create>>
2.1.1: create()
: Card
2.1.2: depositRent()
2.1.2.1: validateInput()
2.1.2.2: processPaymentTransaction()
alt
[INVALID CARD INFO]
2.1.3: notifyError()
alt
[NO ENOUGH BALANCE]
2.1.4: notifyError()
2.1.5: saveTransaction()

3.3 Analysis Class Diagrams

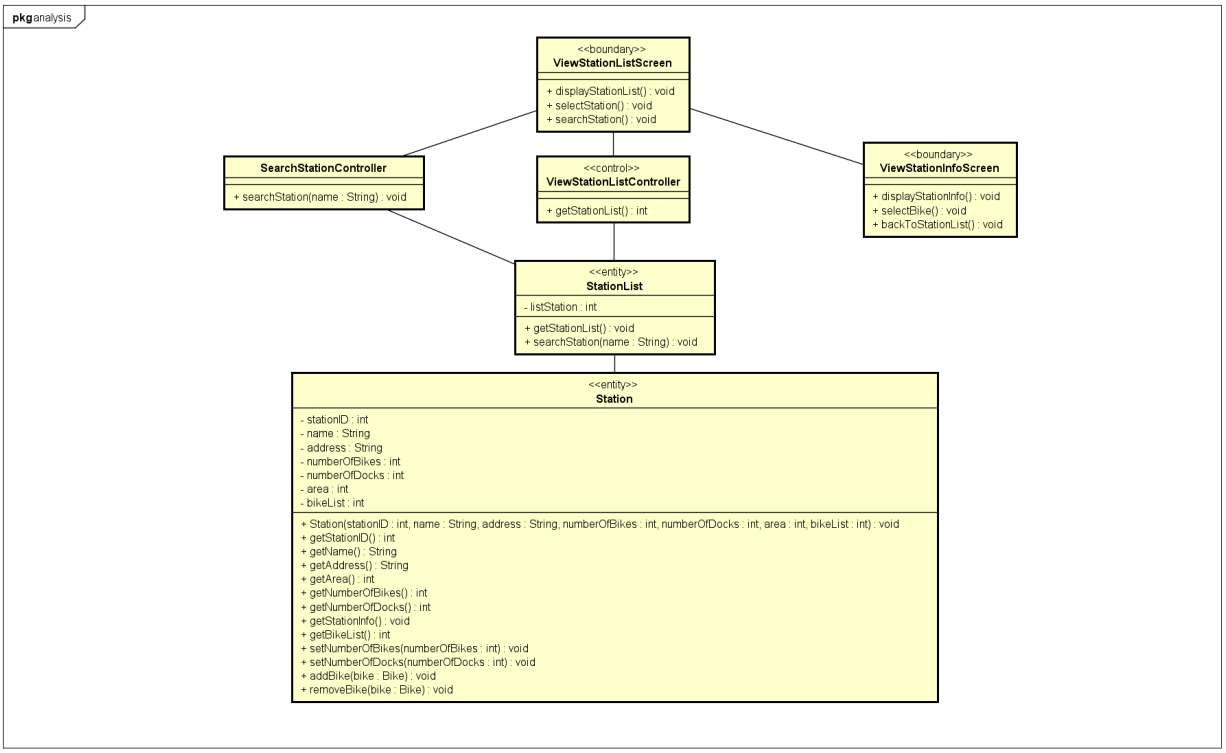
3.3.1 View Dock



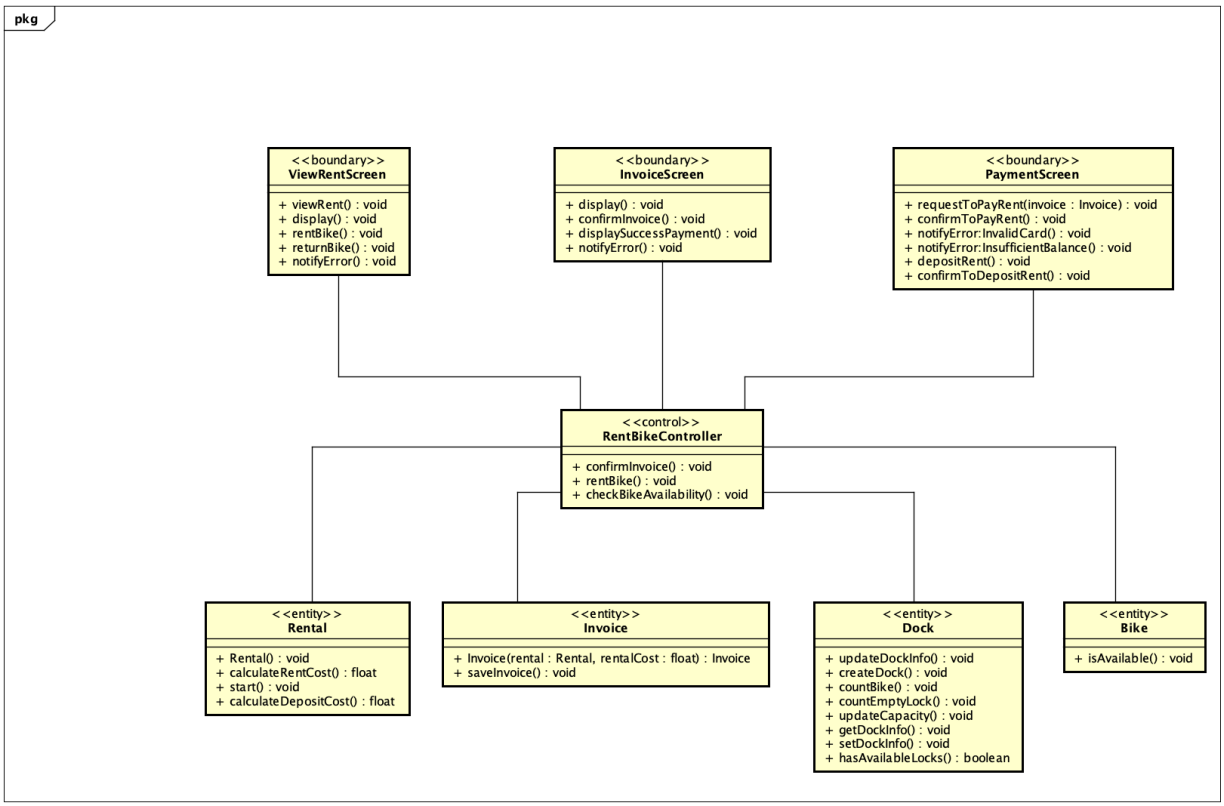
3.3.2 View Bike Info



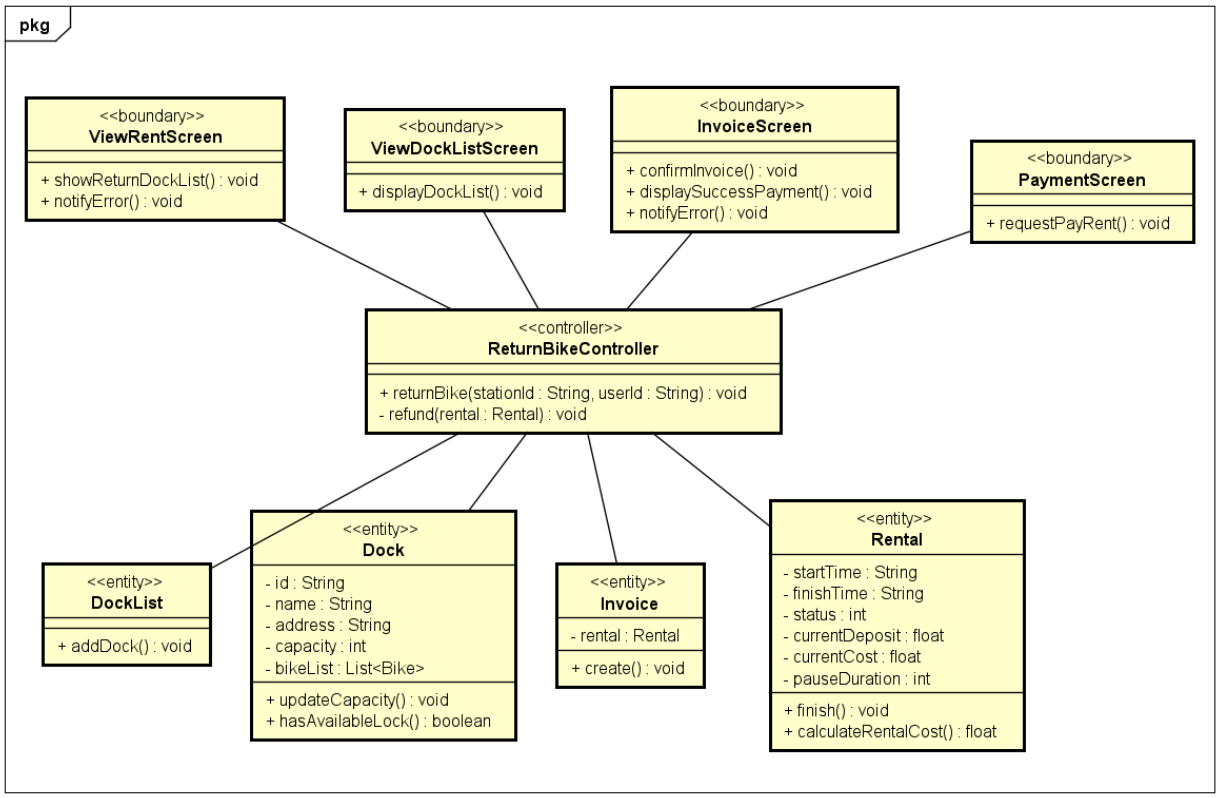
3.3.3 View Dock List:



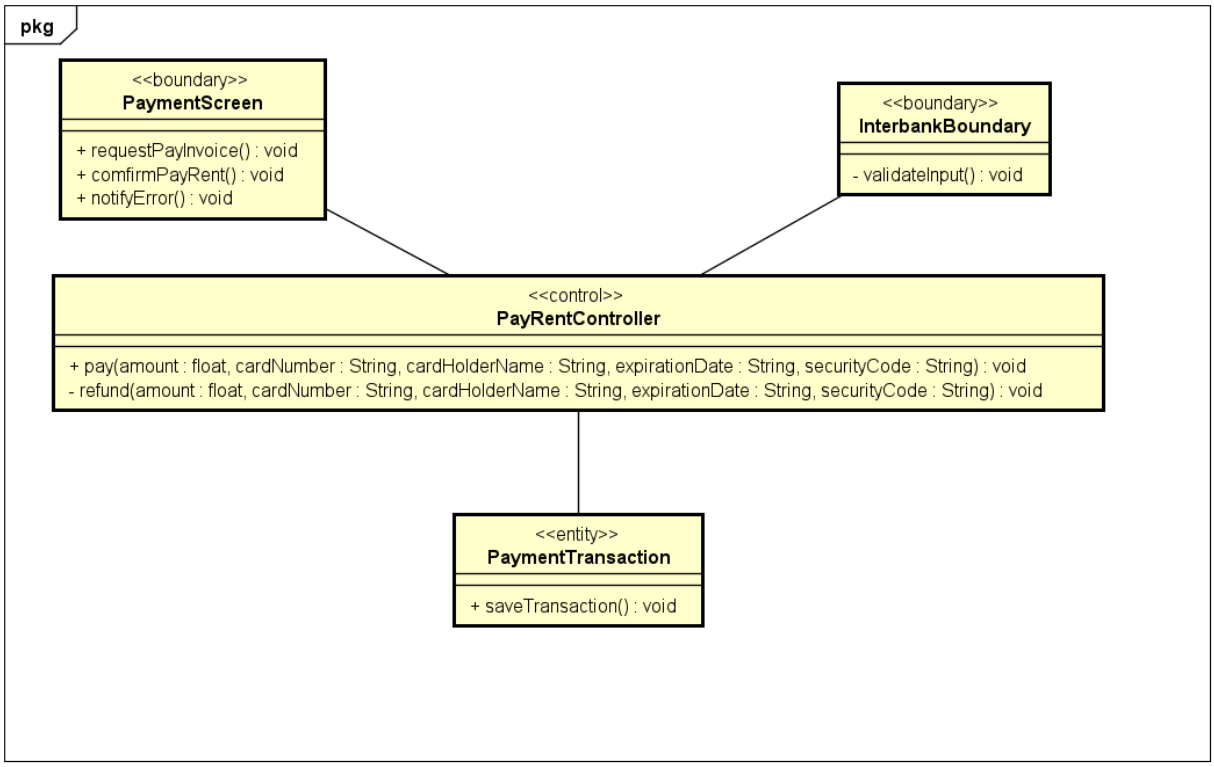
3.3.4 Rent Bike



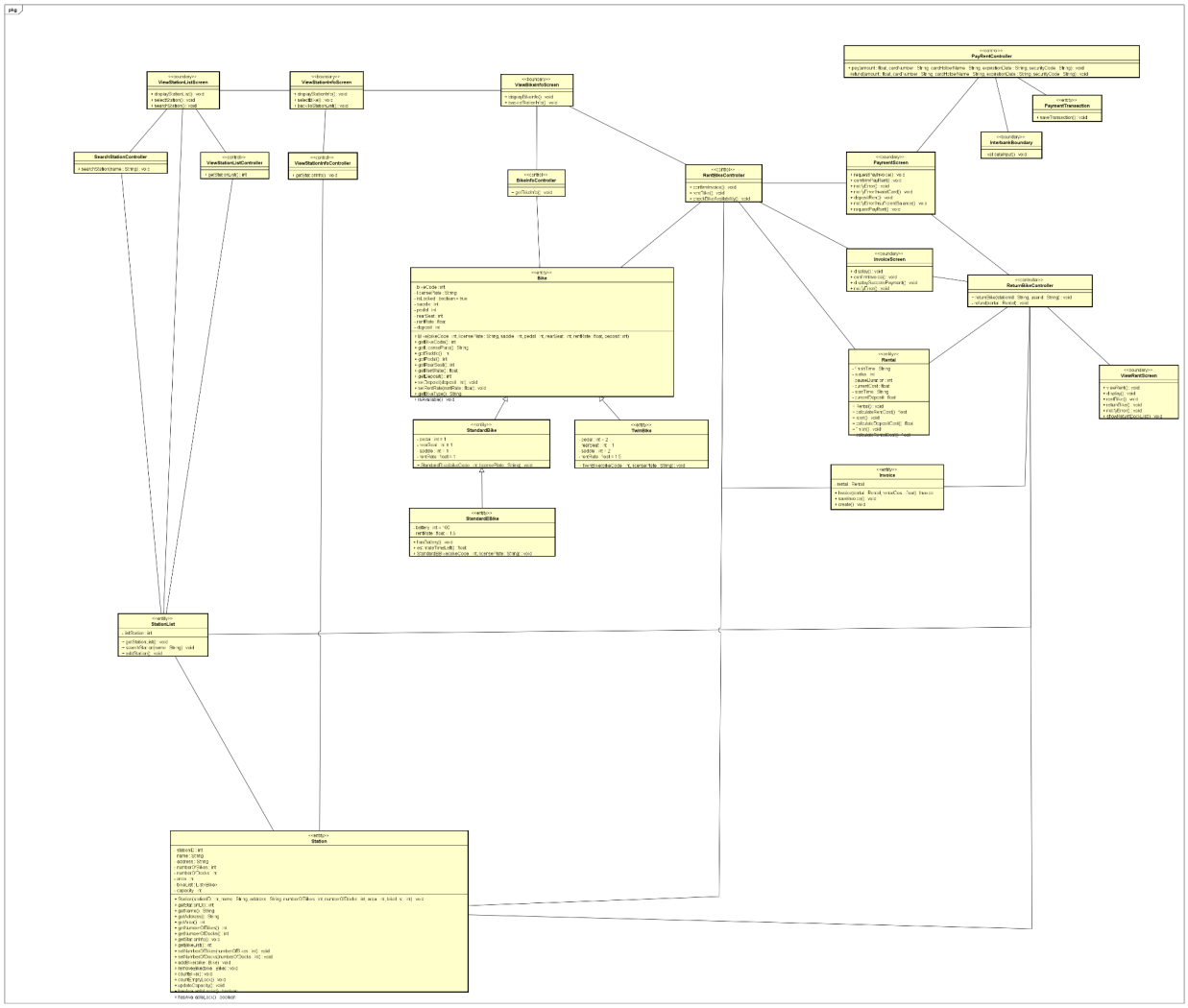
3.3.5 Return Bike


pkg
<<boundary>>
ViewRentScreen
+ showReturnDockList() : void
+ notifyError() : void
<<boundary>>
ViewDockListScreen
+ displayDockList() : void
<<boundary>>
InvoiceScreen
+ confirmInvoice() : void
+ displaySuccessPayment() : void
+ notifyError() : void
<<boundary>>
PaymentScreen
+ requestPayRent() : void
<<controller>>
ReturnBikeController
+ returnBike(stationId : String, userId : String) : void
- refund(rental : Rental) : void
<<entity>>
DockList
+ addDock() : void
<<entity>>
Dock
- id : String
- name : String
- address : String
- capacity : int
- bikeList : List<Bike>
+ updateCapacity() : void
+ hasAvailableLock() : boolean
<<entity>>
Invoice
- rental : Rental
+ create() : void
<<entity>>
Rental
- startTime : String
- finishTime : String
- status : int
- currentDeposit : float
- currentCost : float
- pauseDuration : int
+ finish() : void
+ calculateRentalCost() : float

3.3.6 Pay Rent


pkg
<<boundary>>
PaymentScreen
+ requestPayInvoice() : void
+ comfirmPayRent() : void
+ notifyError() : void
<<boundary>>
InterbankBoundary
- validateInput() : void
<<control>>
PayRentController
+ pay(amount : float, cardNumber : String, cardHolderName : String, expirationDate : String, securityCode : String) : void
- refund(amount : float, cardNumber : String, cardHolderName : String, expirationDate : String, securityCode : String) : void
<<entity>>
PaymentTransaction
+ saveTransaction() : void

3.4 Unified Analysis Class Diagram



3.5 Security Software Architecture

<Describe the software components and configuration supporting the security and privacy of the system. Specify the architecture for (1) authentication to validate user identity before allowing access to the system;(2) authorization of users to perform functional activity once logged into the system, (3) encryption protocol to support the business risks and the nature of information, and (4) logging and auditing design, if required.>

There are some possible risks on deploying this system:

- *Authentication to validate user identity before allowing access to the system*: the information about dock and bikes are available through APIs, so we do not perform authentication at this state.
- *Authorization of users to perform functional activity once logged into the system: After logged into the system, the user can, by default, view bikes and dock stations. The renting comes with a preposition that a valid credit card and deposit amount is supplied.*
- *Encryption protocol to support the business risks and the nature of information: we encrypt the password with SHA-512 and 29 bit salt.*
- *Logging and auditing design: default logging on system log, currently no plan for auditing due to limited budget.*

4 Detailed Design

4.1 User Interface Design

4.1.1 Screen Configuration Standardization

Display

Number of colors supported: 16,777,216 colors

Resolution: 1366 × 768 pixels

Screen

Location of standard buttons: At the bottom (vertically) and in the middle (horizontally) of the frame.

Location of the messages: Starting from the top vertically and in the middle horizontally of the frame down to the bottom.

Display of the screen title: The title is located at the top of the frame on the left-hand.

Consistency in expression of alphanumeric numbers: comma for separator of thousand while strings only consist of characters, digits, commas, dots, spaces, underscores, and hyphen symbol.

Control

Size of the text: medium size (mostly 24px). Font: Segoe UI. Color: #000000

Input check process: Should check if it is empty or not. Next, check if the input is in the correct format or not

Sequence of moving the focus: There will be no stack frames. Each screen will be separated except for the error screen. The error screen is considered a popup, as the main screen cannot be operated while the error screen is shown. After the opening screen, the app will start with the first screen (home screen).

Sequences of the system screens:

1. Home screen – Dock list screen

3. Dock details screen – view detail information of dock station

4. Rent bike screen – input the bike barcode

5. View rent bike screen – view details of current renting

6. Return bike screen

7. Invoice screen – view invoice details

8. Payment screen – fill in payment information

9. Result screen - view the result of the payment transaction

10. Error screen - view information of errors occurred

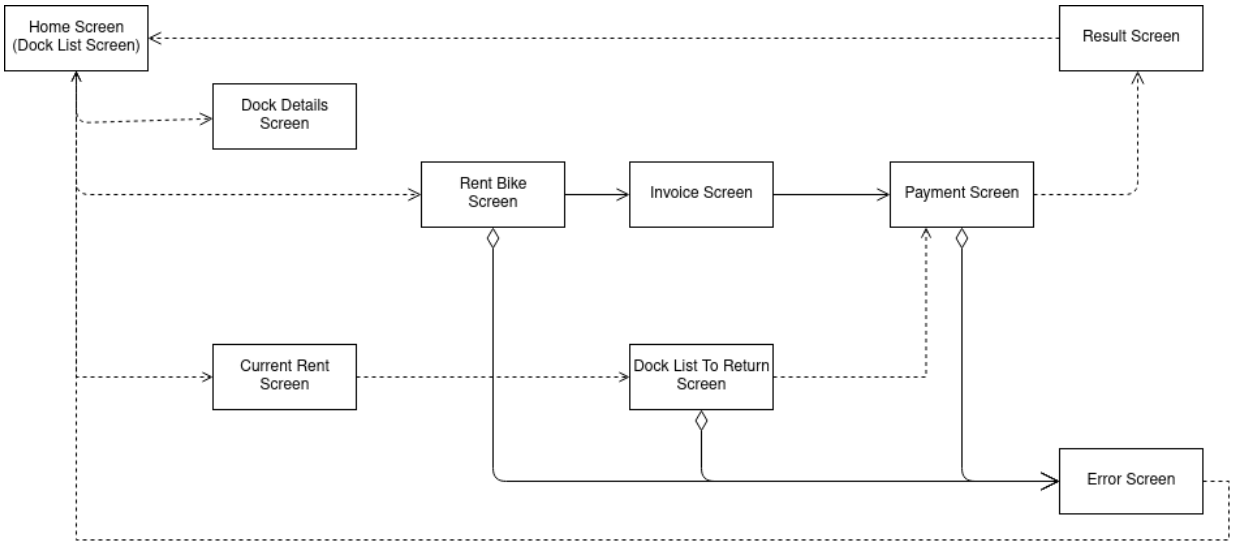
Direct input from the keyboard

There will be no shortcuts. There are back buttons to move back to the previous screen. Also, there is the close button "X" located at the title bar to the right to close the screen.

Error

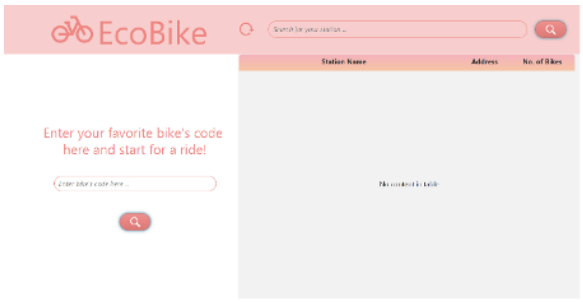
A message will be given to notify the users what is the problem.

4.1.2 Screen Transition Diagrams



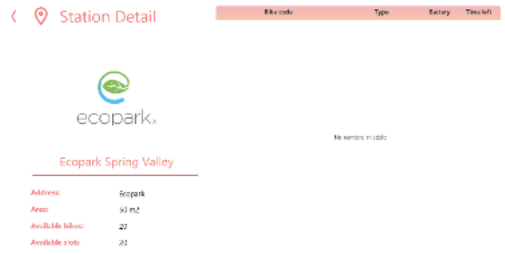
4.1.3 Screen Specifications

4.1.3.1 Home Screen

EcoBike Software		**Date of creation**	**Approved by**	**Reviewed by**	**Person in charge**
Screen specification	Home screen	30/10/2021			Nguyen Huy Hoang
		**Control**	**Operation**	**Function**	
		Area for displaying search dock bar	Initial	Display the search bar to search for docks	
		Area for displaying docks	Initial	Display docks that match the search	
		Area for display bike code search	Click	Display the bike code search	

Item name	**Number of digits (bytes)**	**Type**	**Field attribute**	**Remark**
Search dock bar	120	String	Black	Left-justified
Bike code search	20	String	Black	Left-justified
Station Name	30	String	Black	Left-justified
No. of bikes	5	Numeral	Black	Center-justified
Address	100	String	Black	Left-justified

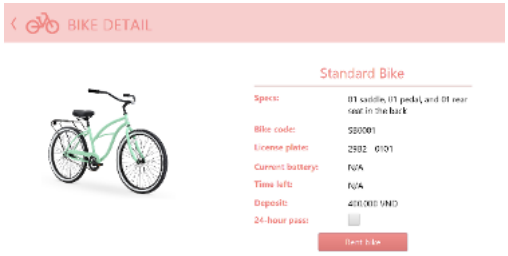
4.1.3.2 Dock Details Screen

EcoBike		**Date of creation**	**Approved by**	**Reviewed by**	**Person in charge**
Screen specification	Dock details screen	30/10/2021			Nguyen Huy Hoang
		**Control**	**Operation**	**Function**	
		Area for displaying dock information	Initial	Display dock information	
		Area for bike information	Initial	Display information of bikes in dock	
		Rent button	Click	Go to rent screen of bike with the code	
		Back button	Click	Return to previous screen	

Item name	**Number of digits (bytes)**	**Type**	**Field attribute**	**Remark**
Dock name	50	String	Black	Left-justified
Dock address	100	String	Black	Left-justified
Number of available bikes	20	Numeral	Black	Left-justified
Number of available slots	20	Numeral	Black	Left-justified
Bike code	20	String	Black	Center-justified
Bike type	50	String	Black	Center-justified
Bike battery	50	String	Black	Center-justified
Time left	50	Numeral	Black	Center-justified

4.1.3.3 Rent Bike Screen

EcoBike		**Date of creation**	**Approved by**	**Reviewed by**	**Person in charge**
Screen specification	Rent bike screen	30/10/2021			Nguyen Huy Hoang

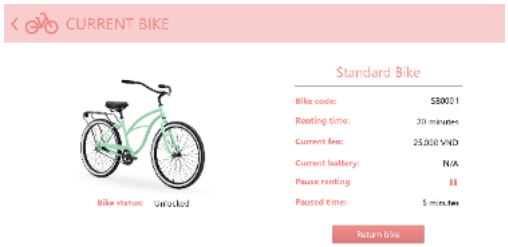


Control	**Operation**	**Function**
Area for display bike info	Initial	Display information of bike
Rent bike button	Click	Rent the current bike
Back button	Click	Return to previous screen

Item name	**Number of digits (bytes)**	**Type**	**Field attribute**	**Remark**
Specs	100	String	Black	Left-justified
Bar code	20	String	Black	Left-justified
Liscence plate	20	String	Black	Left-justified
Current battery	50	String	Black	Left-justified
Time left	50	Numeral	Black	Left-justified
Deposit	50	String	Black	Left-justified
24-hour pass	1	Boolean	Black	Left-justified

4.1.3.4 View Rent Bike Screen

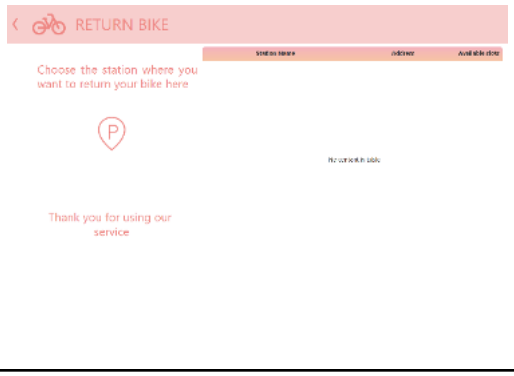
EcoBike		**Date of creation**	**Approved by**	**Reviewed by**	**Person in charge**
Screen specification	View Rent bike screen	31/10/2021			Nguyen Huy Hoang

	**Control**	**Operation**	**Function**
	Area for display renting information	Initial	Display renting information
	Area for display bike image	Initial	Display bike image
	Return bike button	Click	Renturn bike
	Back button	Click	Return to previous screen

Item name	**Number of digits (bytes)**	**Type**	**Field attribute**	**Remark**
Bike code	20	String	Black	Right-justified
Renting time	50	String	Black	Right-justified
Current fee	20	Numeral	Black	Right-justified
Current battery	50	String	Black	Right-justified
Pause time	20	String	Black	Right-justified
Bike status	50	String	Black	Right-justified

4.1.3.5 Return bike Screen

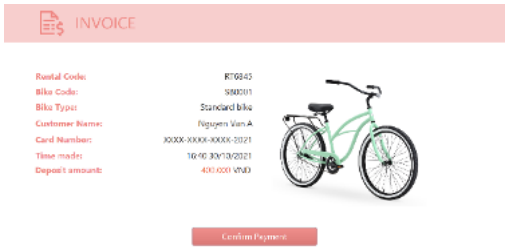
EcoBike		**Date of creation**	**Approved by**	**Reviewed by**	**Person in charge**
Screen specification	Return bike screen	30/10/2021			Nguyen Huy Hoang

	**Control**	**Operation**	**Function**
	Area for displaying dock	Initial	Display dock information
	Back button	Click	Return to previous screen

Item name	**Number of digits (bytes)**	**Type**	**Field attribute**	**Remark**
Dock name	50	String	Black	Right-justified
Dock address	100	String	Black	Right-justified
Number of available slots	20	Numeral	Black	Right-justified

4.1.3.6 Invoice Screen

EcoBike		**Date of creation**	**Approved by**	**Reviewed by**	**Person in charge**
Screen specification	Invoice screen	30/10/2021			Nguyen Huy Hoang

	**Control**	**Operation**	**Function**
	Area for renting information	Initial	Display renting information
	Confirm button	Click	Confirm payment
	Back button	Click	Return to previous screen

Item name	**Number of digits (bytes)**	**Type**	**Field attribute**	**Remark**

Rental code	20	String	Black	Right-justified
Bike code	20	String	Black	Right-justified
Bike type	50	String	Black	Right-justified
Customer name	50	String	Black	Right-justified
Deposit	20	Numeral	Black	Right-justified
Card number	50	String	Black	Right-justified

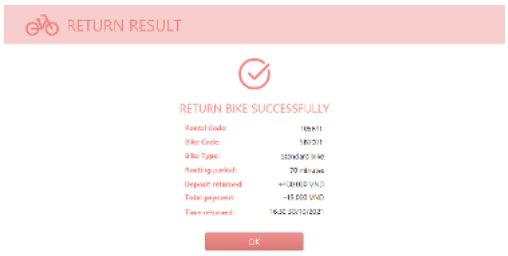
4.1.3.7 Payment Screen

EcoBike Software		**Date of creation**	**Approved by**	**Reviewed by**	**Person in charge**
Screen specification	Payment screen	30/10/2021			Nguyen Huy Hoang
		**Control**	**Operation**	**Function**	
		Area for displaying card information	Initial	Display card information	
		Confirm button	Click	Confirm Card	
		Back button	Click	Return to previous screen	

Item name	**Number of digits (bytes)**	**Type**	**Field attribute**	**Remark**
Card number	50	String	Black	Left- justified

Card Holder Name	100	String	Black	Left- justified
Expiration month	2	Numeral	Black	Left- justified
Expiration year	2	Numeral	Black	Left- justified
CVV	6	String	Black	Centered

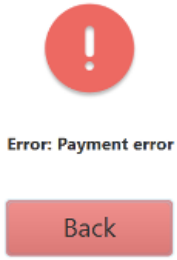
4.1.3.8 Result Screen

EcoBike		**Date of creation**	**Approved by**	**Reviewed by**	**Person in charge**
Screen specification	Result screen	30/10/2021			Nguyen Huy Hoang
		**Control**	**Operation**	**Function**	
		Area for result information	Initial	Display result of renting	
		OK button	Click	Direct to view rent screen	

Item name	**Number of digits (bytes)**	**Type**	**Field attribute**	**Remark**
Rental code	20	String	Black	Right- justified
Bike code	20	String	Black	Right- justified
Bike type	50	String	Black	Right- justified
Renting period	50	String	Black	Right- justified
Deposit returned	50	String	Black	Right- justified
Total payment	50	String	Black	Right- justified

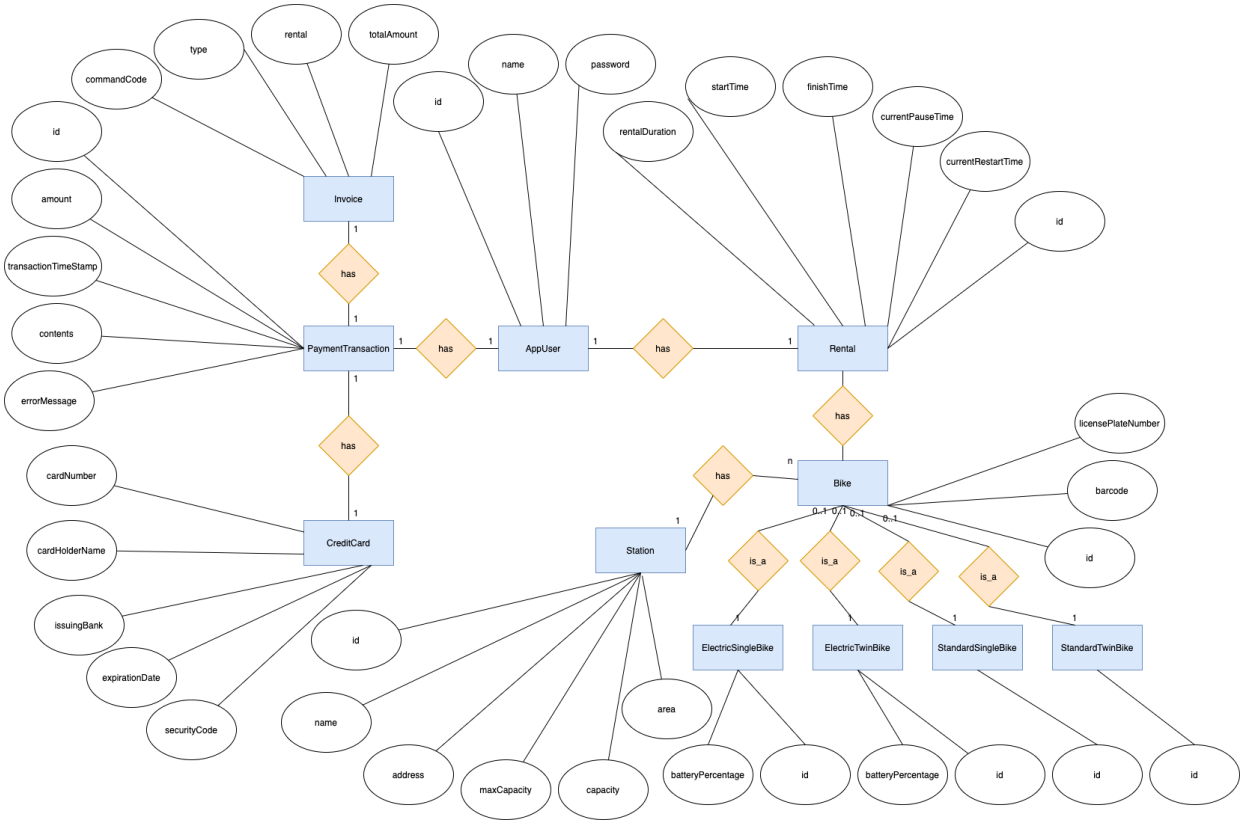
Time returned	50	Datetime	Black	Right- justified

4.1.3.9 Error Screen

EcoBike		**Date of creation**	**Approved by**	**Reviewed by**	**Person in charge**
Screen specification	Error screen	30/10/2021			Nguyen Huy Hoang
		**Control**	**Operation**	**Function**	
		Area for displaying error	Initial	Display the error	
		OK button	Click	Go to home screen	

4.2 Data Modeling

4.2.1 Conceptual Data Modeling



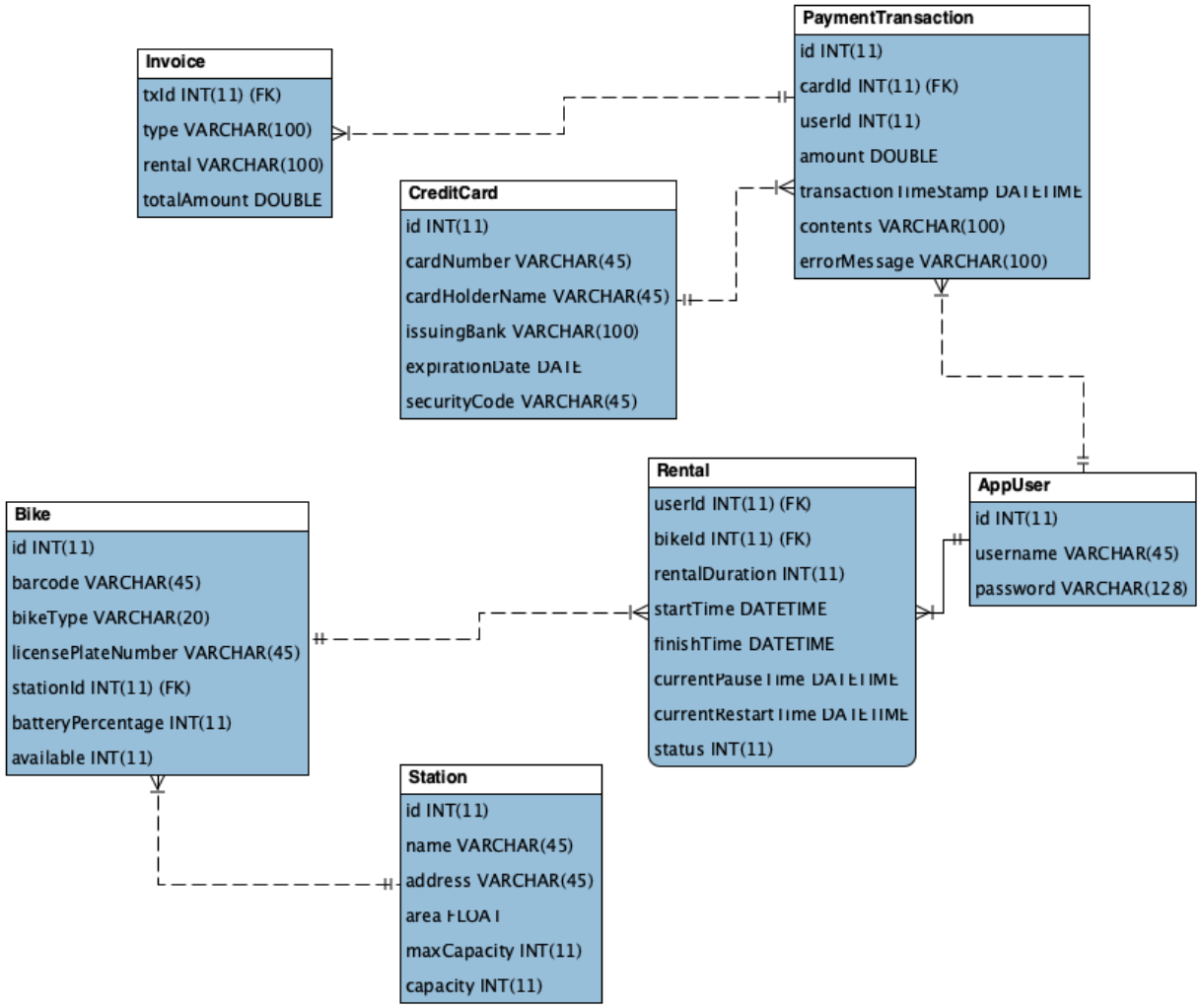
4.2.2 Database Design

4.2.2.1 Database Management Systems

Database Management System: MySQL

MySQL is an open-source relational database management system.

4.2.2.2 Logical Data Model



4.2.2.3 Physical Data Model

AppUser

#	PK	FK	Column Name	Data Type	Mandatory	Description
1	X		id	Integer	Yes	Id, auto increment
2			username	Varchar(45)	Yes	Name of user
3			password	Varchar(128)	Yes	Password of user

Rental

#	PK	FK	Column Name	Data Type	Mandatory	Description

1	x	x	userId	Integer	Yes	User's ID
2	x	x	bikeID	Integer	Yes	Bike's ID
3			rentalDuration	Integer	Yes	Duration of renting
4			startTime	Datetime	Yes	Time start renting
5			finishTime	Datetime	Yes	Time finish renting
6			currentPauseTime	Datetime	Yes	Current time of pausing
7			currentRestartTime	Datetime	Yes	Current time of restarting
8			status	Integer	Yes	Status of renting

Bike

#	PK	FK	Column Name	Data Type	Mandatory	Description
1	X		id	Integer	Yes	Id, auto increment
2			barcode	Varchar(45)	Yes	Barcode of bike
3			bikeType	Varchar(20)	Yes	The type of the bike
4			licensePlateNumber	Varchar(45)	Yes	License plate number of bike
5		X	stationId	Integer	No	station's ID
6			batteryPercentage	Integer	No	The battery percentage of the bike
7			available	Integer	Yes	The availability of the bike

Station

#	PK	FK	Column Name	Data Type	Mandatory	Description
1	X		id	Integer	Yes	Id, auto increment
2			name	Varchar(45)	Yes	Name of station

3			address	Varchar(45)	Yes	Address of station
4			area	Float	Yes	The area of the station
5			maxCapacity	Integer	Yes	Max capacity of station
6			capacity	Integer	Yes	Current capacity of station

PaymentTransaction

#	PK	FK	Column Name	Data Type	Mandatory	Description
1	X		id	Integer	Yes	Id, auto increment
2		x	cardId	Integer	Yes	Card's ID
3		x	userId	Integer	Yes	User's ID
4			amount	Integer	Yes	Amount of transaction
5			transactionTimeStamp	Datetime	Yes	Time of transaction
6			contents	Varchar(100)	Yes	Contents of transaction
7			errorMessage	Varchar(100)	Yes	Error message of transaction

Credit Card

#	PK	FK	Column Name	Data Type	Mandatory	Description
1	X		id	Integer	Yes	Id, auto increment
2			cardNumber	Varchar(45)	Yes	Number of card
3			cardHolderName	Varchar(45)	Yes	Holder name of card
4			issuingBank	Varchar(100)	Yes	Issuing bank of card
5			expirationDate	Date	Yes	Error message of transaction
6			securityCode	Varchar(45)	Yes	Expiration Date of card

Invoice

#	PK	FK	Column Name	Data Type	Mandatory	Description
1	x		txId	Integer	Yes	Id, auto increment
2			type	Varchar(100)	Yes	Type of payment: deposit, payment, refund
3			rental	Varchar(100)	Yes	Status: pay or refund
4			totalAmount	Varchar(100)	Yes	Renting money

Database Script:

```
CREATE TABLE AppUser(
   id INTEGER PRIMARY KEY AUTO_INCREMENT NOT NULL,
   username VARCHAR(45) NOT NULL,
   password VARCHAR(128) NOT NULL
);

CREATE TABLE Station(
   id INTEGER PRIMARY KEY AUTO_INCREMENT NOT NULL,
   name VARCHAR(45) NOT NULL,
   address VARCHAR(45) NOT NULL,
   area FLOAT NOT NULL,
   maxCapacity INTEGER NOT NULL,
   capacity INTEGER NOT NULL
);

CREATE TABLE Bike(
        id INTEGER PRIMARY KEY AUTO_INCREMENT NOT NULL,
   barcode VARCHAR(45) NOT NULL,
```

```
    bikeType VARCHAR(20) NOT NULL,
    licensePlateNumber VARCHAR(45) NOT NULL,
    stationId INTEGER,
    batteryPercentage INTEGER DEFAULT 0,
    available INTEGER DEFAULT 1,
    CONSTRAINT fk_Bike_Station1 FOREIGN KEY (stationId) REFERENCES Station(id)
);

CREATE TABLE Rental(
    userId INTEGER NOT NULL,
    bikeId INTEGER NOT NULL,
    rentalDuration INTEGER DEFAULT 0,
    startTime DATETIME DEFAULT CURRENT_TIMESTAMP,
    finishTime DATETIME,
        currentPauseTime DATETIME,
        currentRestartTime DATETIME,
        status INTEGER DEFAULT 0,
        PRIMARY KEY (userId, startTime),
        CONSTRAINT fk_Rental_User1 FOREIGN KEY(userId) REFERENCES AppUser(id),
    CONSTRAINT fk_Rental_Bike1 FOREIGN KEY(bikeId) REFERENCES Bike(id)
);

CREATE TABLE CreditCard(
    id INTEGER PRIMARY KEY AUTO_INCREMENT NOT NULL,
    cardNumber VARCHAR(45) NOT NULL,
    cardHolderName VARCHAR(45) NOT NULL,
    issuingBank VARCHAR(100) NOT NULL,
    expirationDate DATE NOT NULL,
```

```
    securityCode VARCHAR(45) NOT NULL
);

CREATE TABLE PaymentTransaction(
    id INTEGER PRIMARY KEY AUTO_INCREMENT NOT NULL,
    cardId INTEGER NOT NULL,
    userId INTEGER NOT NULL,
    amount REAL NOT NULL,
    transactionTimeStamp DATETIME NOT NULL,
    contents VARCHAR(100) NOT NULL,
    errorMessage VARCHAR(100) NOT NULL,
        CONSTRAINT fk_PaymentTransaction_CreditCard1 FOREIGN KEY(cardId)REFERENCES CreditCard(id),
        CONSTRAINT fk_PaymentTransaction_User1 FOREIGN KEY(cardId)REFERENCES AppUser(id)
);

CREATE TABLE Invoice(
    txId INTEGER DEFAULT NULL,
    type VARCHAR(100) NOT NULL,
    rental VARCHAR(100) NOT NULL,
    totalAmount REAL NOT NULL,
        PRIMARY KEY(type,rental),
        CONSTRAINT fk_Invoice_PaymentTransaction1 FOREIGN KEY(txId)REFERENCES PaymentTransaction(id)
);
```

4.3 Non-Database Management System Files

- Config file for bike types:

  Attributes recorded for each bike type:

  "bikeTypeName",

  "monetaryValue",

  "electricBike",

  "noOfSaddles",

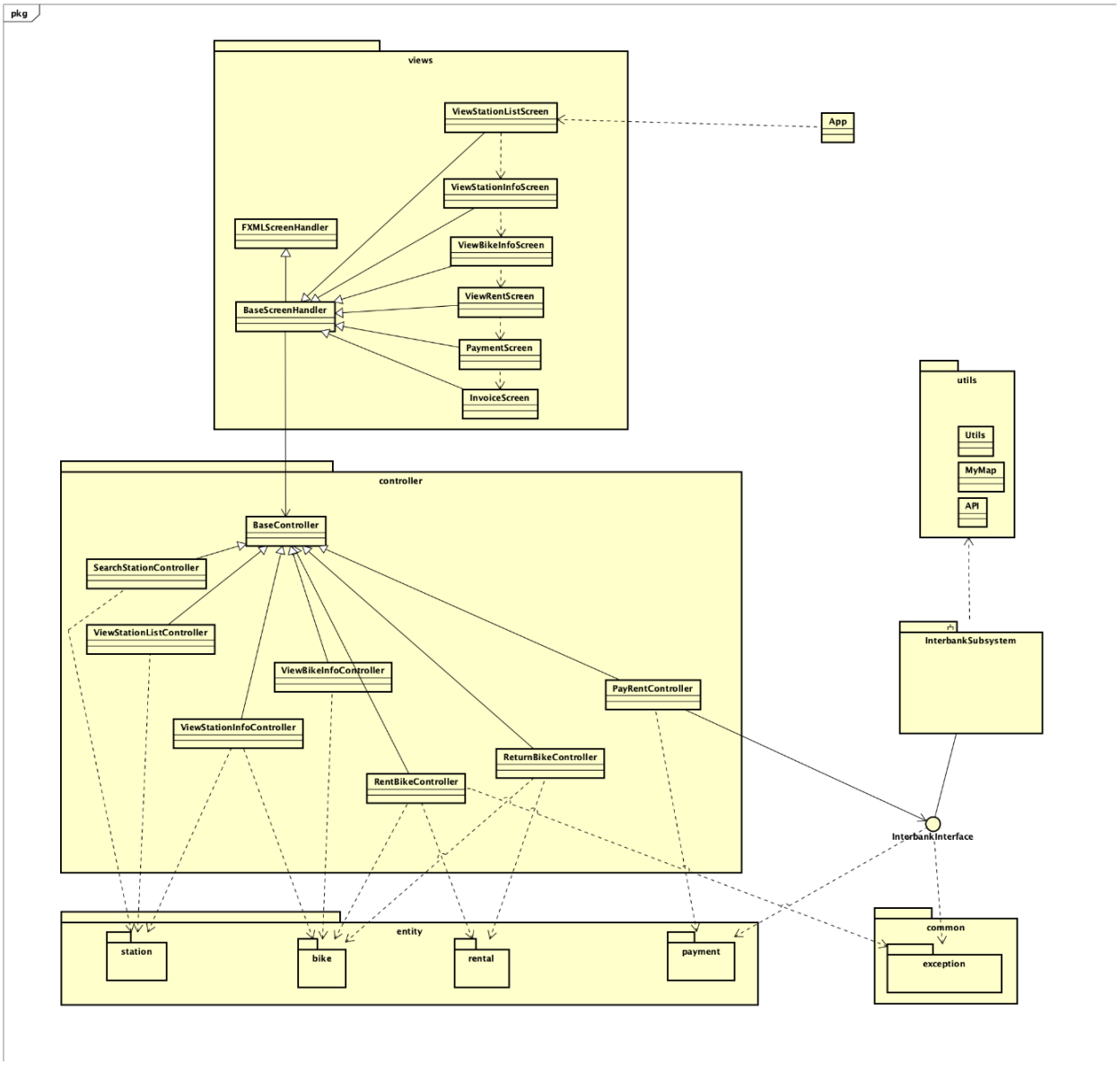
  "noOfPedals",

  "noOfRearSeats",

  "description"

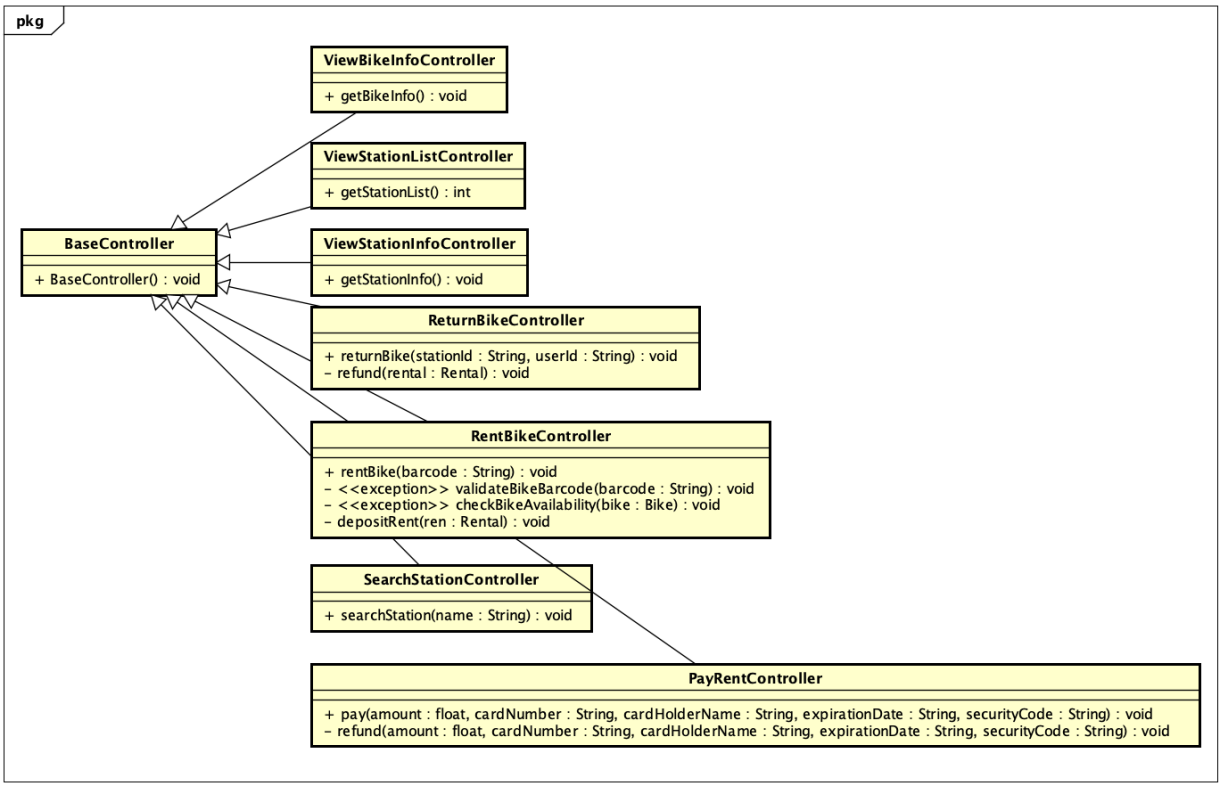
4.4 Class Design

4.4.1 General Class Diagram

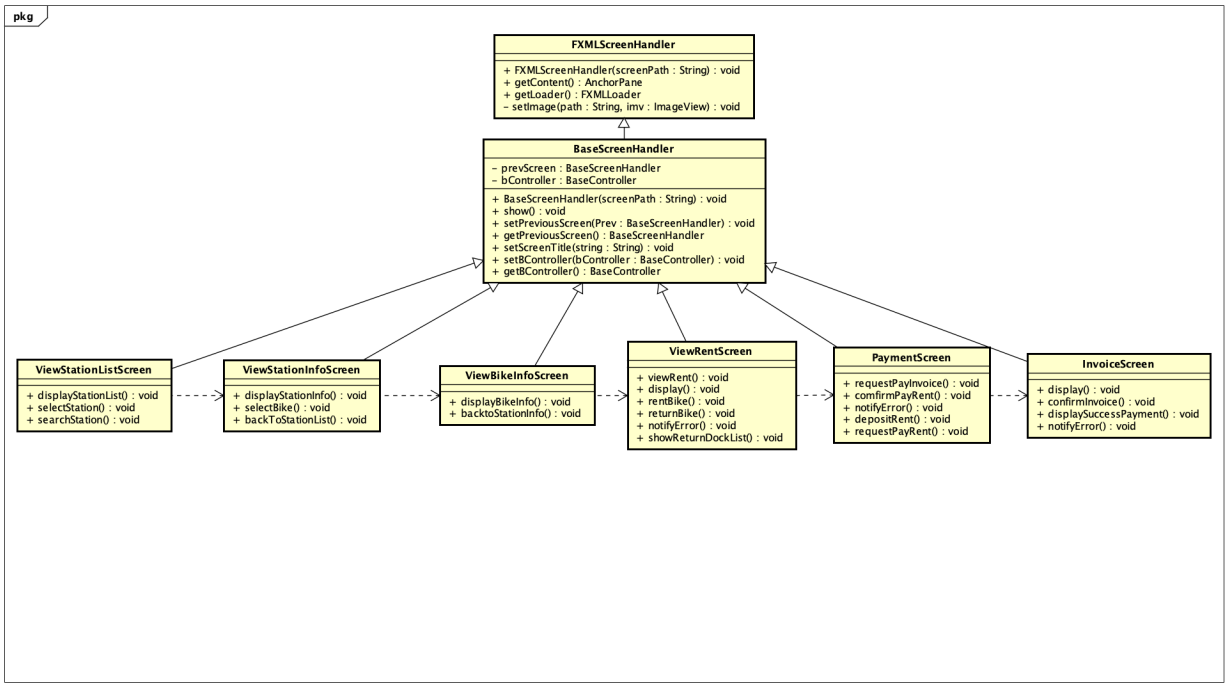


4.4.2 Class Diagrams

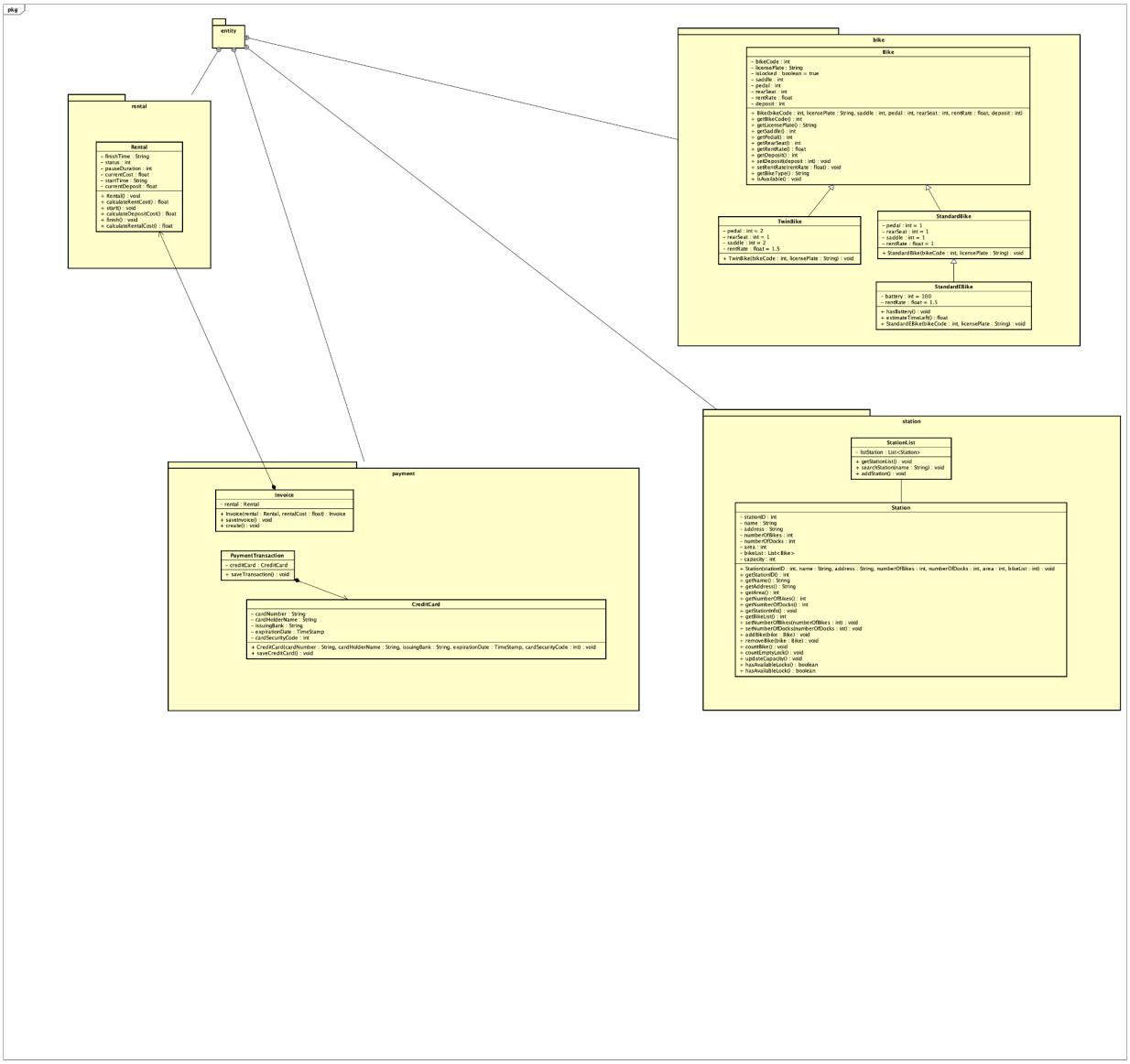
4.4.2.1 Class Diagram for Package "Controller"



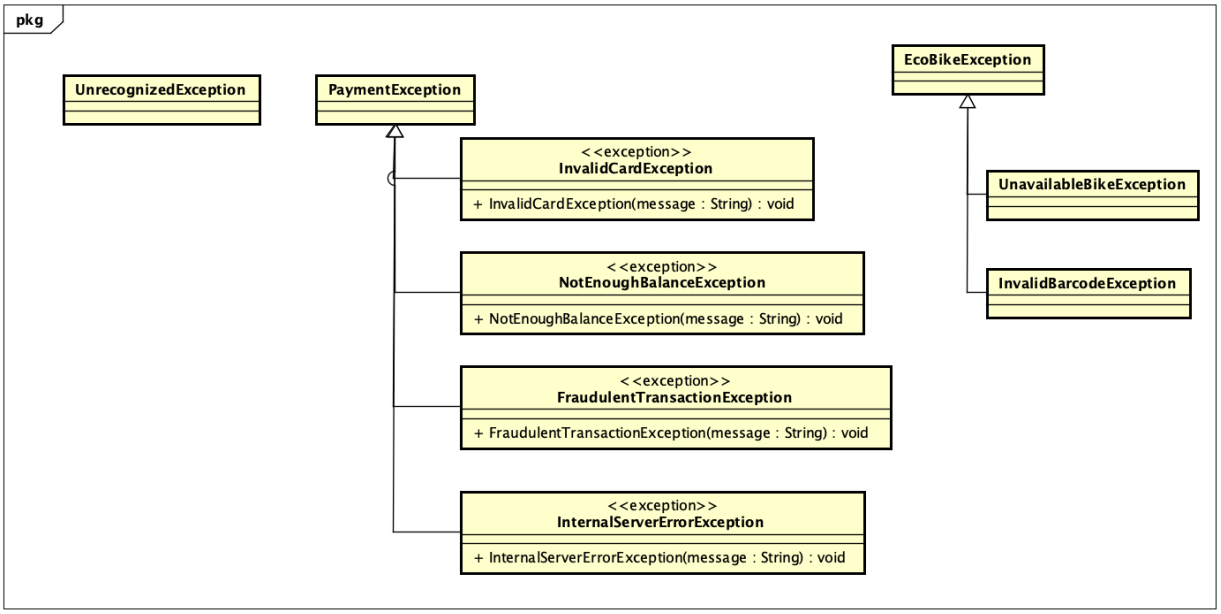
4.4.2.2 Class Diagram for Package "View-handler"



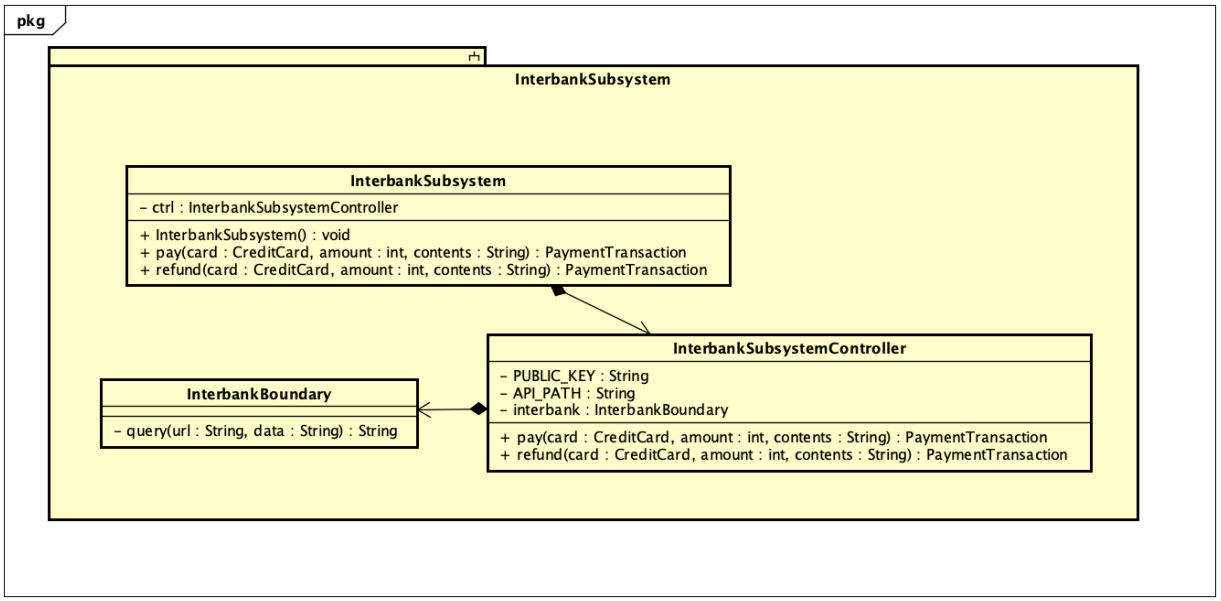
4.4.2.3 Class Diagram for Package “Entity”



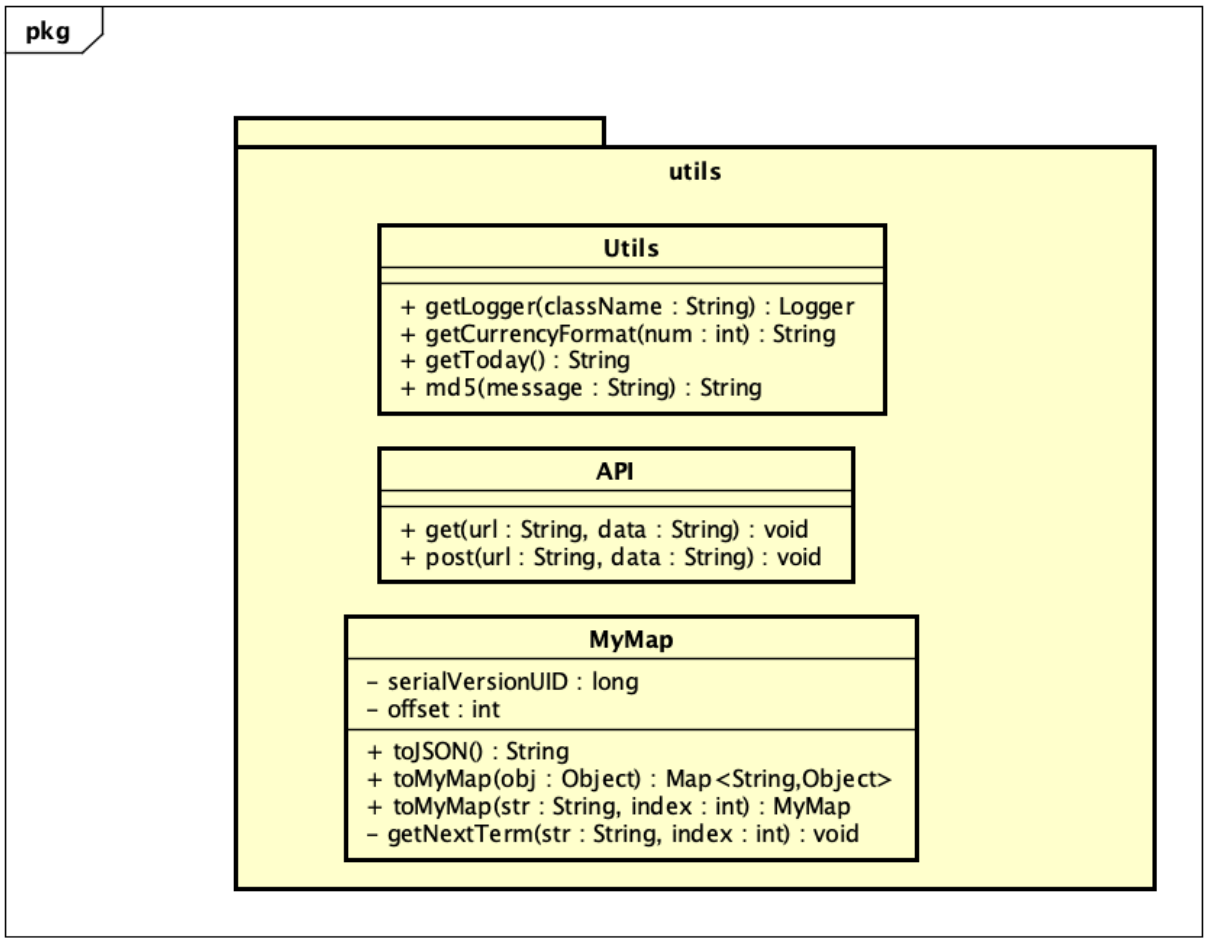
4.4.2.4 Class Diagram for Package "Exception"



4.4.2.5 Class Diagram for Subsystem "Interbank"

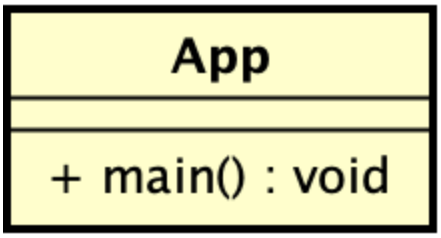


4.4.2.6 Class Diagram for Package "Utils"



4.4.3 Class Design

4.4.3.1 Class "App"



Attribute

None

Operation

#	*Name*	*Return type*	*Description (purpose)*
1	main	void	The main entry point for the application

Parameter:

None

Exception:

None

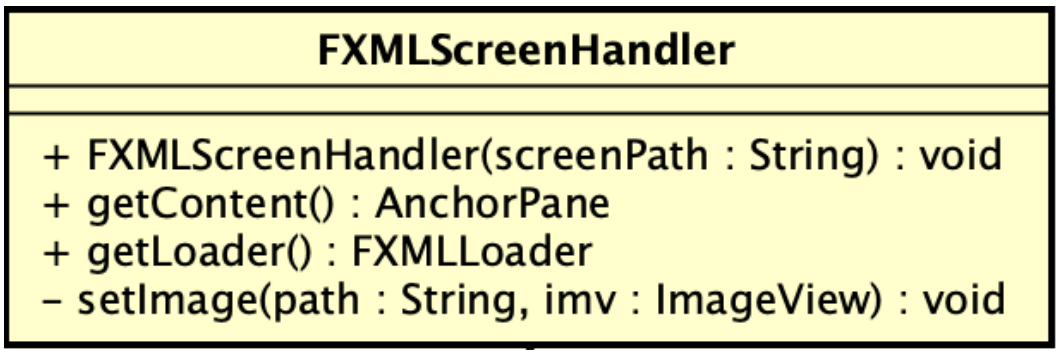
Method

None

State

None

4.4.3.2 Class "FXMLScreenHandler"



Attribute

None

Operation

#	*Name*	*Return type*	*Description (purpose)*
1	FXMLScreenHandler	void	Constructs a FXMLScreenHandler from a screenPath
2	getContent	AnchorPane	Gets the root of the screen
3	getLoader	FXMLLoader	Gets the loader

Parameter:

- screenPath: the path to the fxml file of the screendock

Exception:

- None

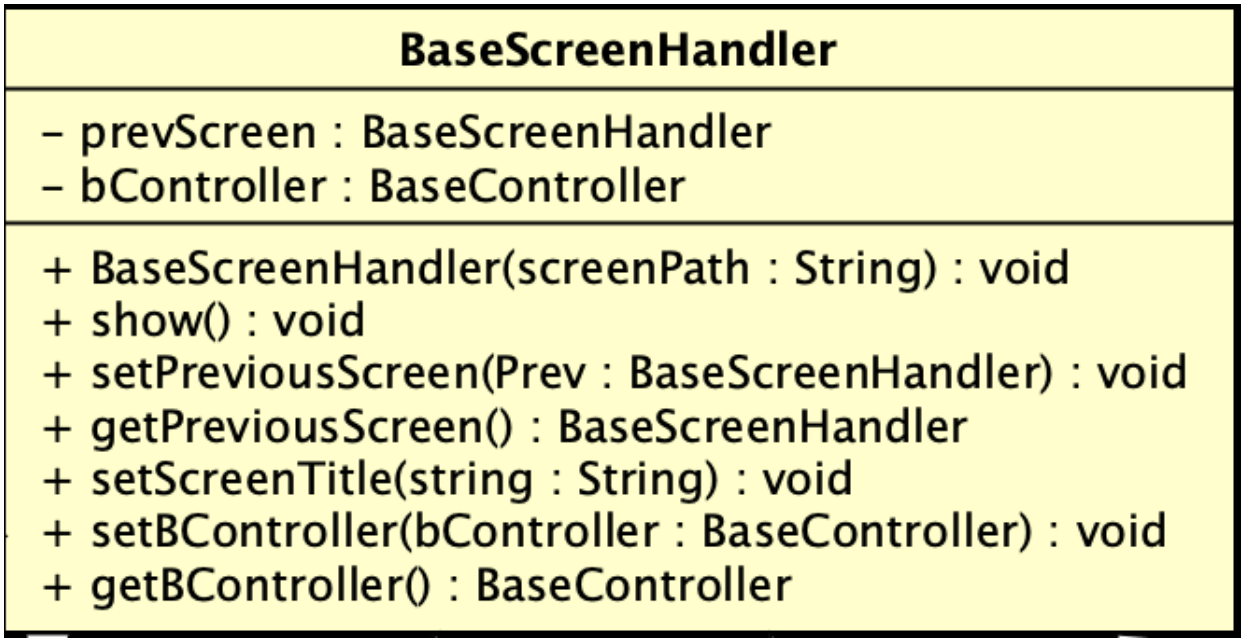
Method

- setImage: Sets image file in *path* to the ImageView *imv*

State

None

4.4.3.3 Class "BaseScreenHandler"



Attribute

#	Name	Data type	Default value	Description
1	prevScreen	BaseScreenHandler		Represents the previous screen (in case the user go back)
2	bController	BaseController		Represents the BaseController for the screen

Operation

#	*Name*	*Return type*	*Description (purpose)*
1	BaseScreenHandler	void	Constructs a FXMLScreenHandler from a screenPath
2	show		Shows the screen to the user

Parameter:

- screenPath: the path to the fxml file of the screen

Exception:

- None

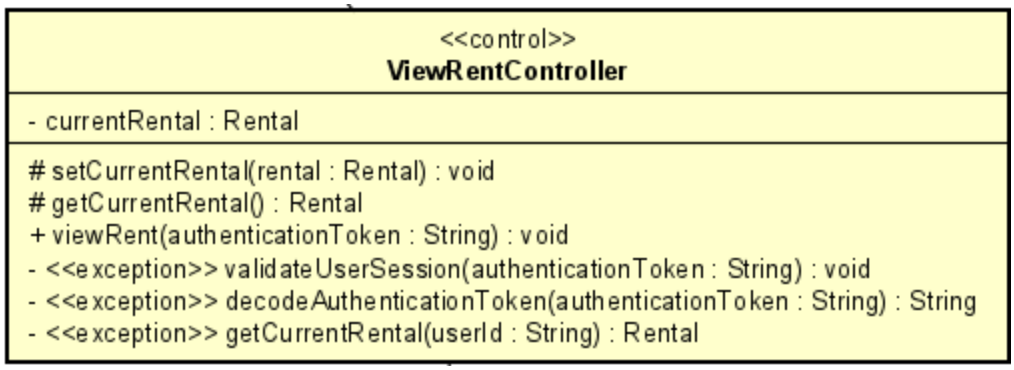
Method

- setPreviousScreen: set the screen in BaseScreenHandler *prev* as the previous screen of the current screen
- setPreviousScreen: get the previous screen as a BaseScreenHandler object
- setScreenTitle: set *string* as the title of the screen
- setBController: set the BaseController for the screen
- getBController: get the BaseController of the screen

State

None

4.4.3.4 Class "BaseController"



Attribute

None

Operation

#	*Name*	*Return Type*	*Description*
1	BaseController	void	Constructs a BaseController

Parameter:

None

Exception:

None

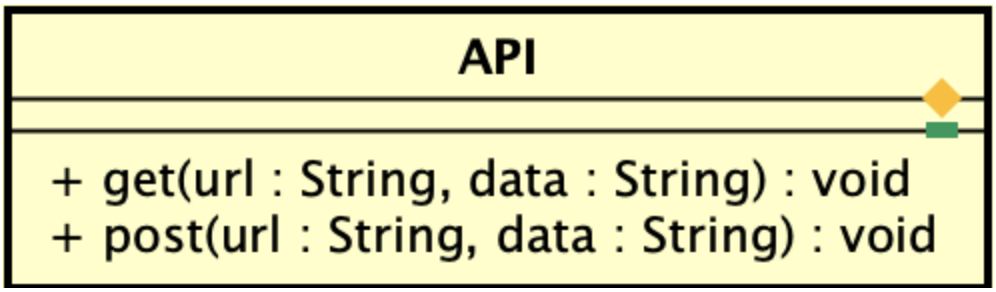
Method:

None

State:

None

4.4.3.5 Class "API"



Attribute

None

Operation

#	Name	Return Type	Description
1	get	String	Make a HTTP GET request to the given url with the given data
2	post	String	Make a HTTP POST request to

			the given url with the given data

Parameter:

- url: the destination url to send the request
- data: the data of the request

Exception:

- None

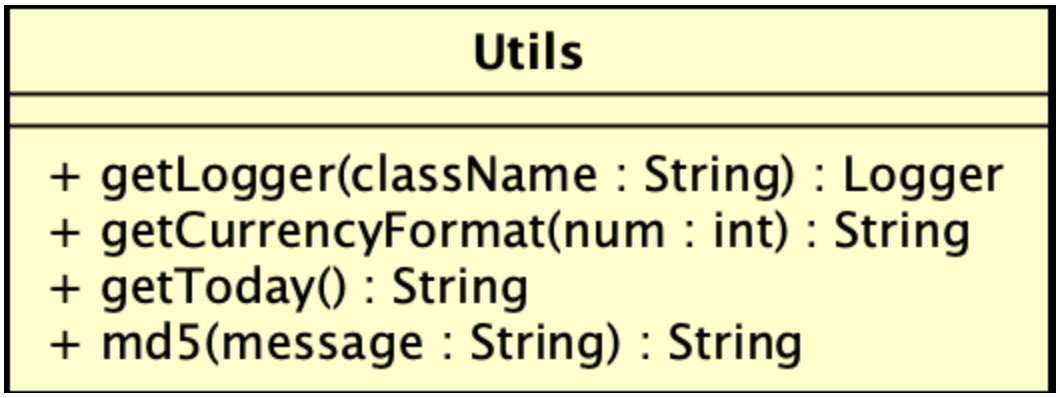
Method:

None

State:

None

4.4.3.6 Class "Utils"



Attribute

None

Operation

#	*Name*	*Return type*	*Description (purpose)*
1	getLogger	Logger	Gets the logger of the class

2	getCurrencyFormat	String	Return the formatted string according to the currency
3	getToday	String	Return a string representing the current time in the format yyyy-MM-dd HH:mm:ss
4	md5	String	Return the hash value of the message

Parameter:

- className: the name of the class in string format
- num: the amount of currency
- message: the message in string format

Exception:

None

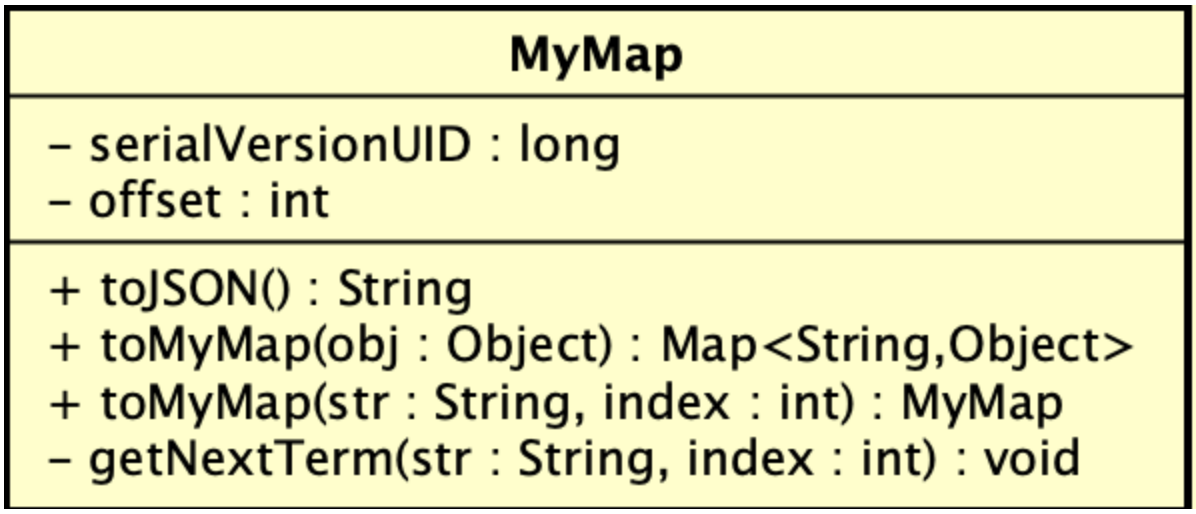
Method

None

State

None

4.4.3.7 Class "MyMap"



Attribute

#	Name	Data type	Default value	Description
1	serialVersionUID	long	1	The serial version UID
2	offset	int	0	Keep track of the current index when calling a function

Operation

#	*Name*	*Return type*	*Description (purpose)*
1	toJSON	String	Return a String that represents a JSON object of the MyMap object
2	toMyMap	Map<String, Object>	Return a Map that represents the mapping among attribute names and their values of the object obj
3	toMyMap	MyMap	Return a MyMap that represents the interested substring in a String

Parameter:

- obj: the object of interest
- string: the atring of interest
- idx: the index of the character in the original string where the substring begins

Exception:

None

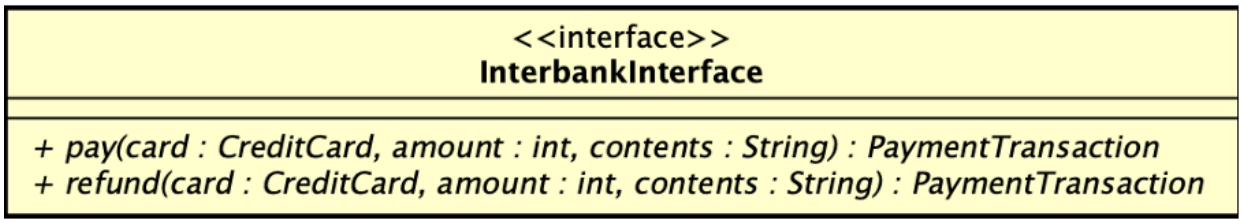
Method

- getNextTerm: Return a string that represents the term in between the double quotes inside a string

State

None

4.4.3.8 Interface "InterbankInterface"



Attribute

None

Operation

#	*Name*	*Return Type*	*Description*
1	pay	PaymentTransaction	Pay rent, then return the payment transaction
2	refund	PaymentTransaction	Refund, then return the payment transaction

Parameter:

- card: the credit card used for payment/refund
- amount: the amount to pay/refund
- contents: the transaction contents

Exception:

- PaymentException: if responded with a pre-defined error code
- UnrecognizedException: if responded with an unknown error code or something goes wrong

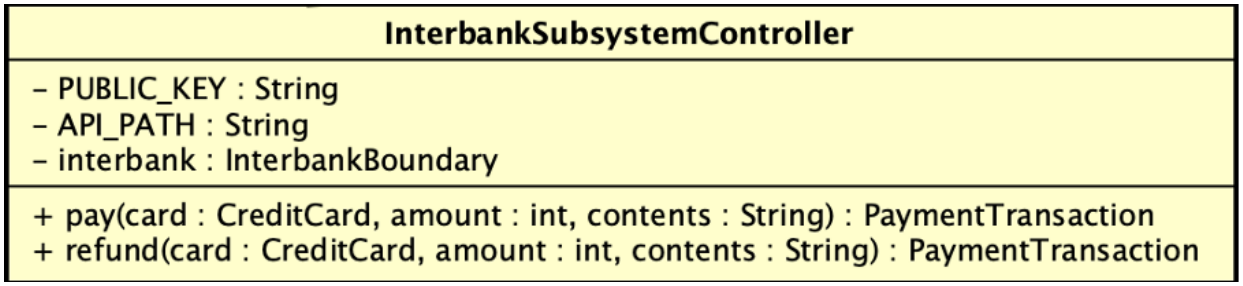
Method:

None

State:

None

4.4.3.9 Class "InterbankSubsystemController"



Attribute

#	Name	Data type	Default value	Description
1	PUBLIC_KEY	String	supply by subsystem	Being used to encode the data sent to interbank api gateway
2	API_PATH	String	supply by subsystem	Path to interbank api gateway
3	interbank	InterbankBoundary	Injected by IoC	Communicate to the interbank api gateway

Operation

#	*Name*	*Return Type*	*Description*
1	pay	PaymentTransaction	Pay rent, then return the payment transaction
2	refund	PaymentTransaction	Refund, then return the payment transaction

Parameter:

- card: the credit card used for payment/refund
- amount: the amount to pay/refund
- contents: the transaction contents

Exception:

- PaymentException: if responded with a pre-defined error code
- UnrecognizedException: if responded with an unknown error code or something goes wrong

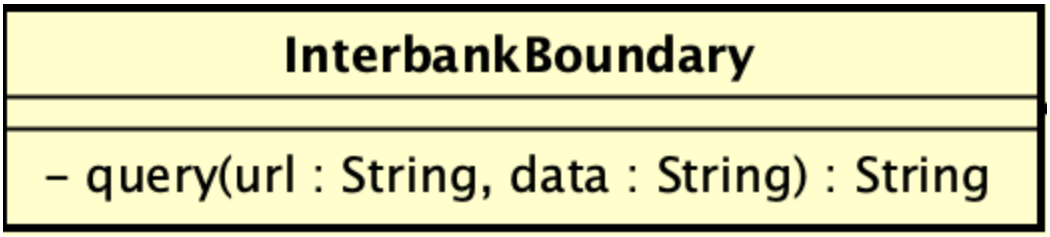
Method:

- generateURL: Generate correctly-form URL satisfied the standard interbank system design
- handleResponse: Read the response returned from the interbank by converting JSON-formatted string into separated list of information

State:

None

4.4.3.10 Class "InterbankBoundary"



Attribute

None

Operation

#	*Name*	*Return Type*	*Description*
1	query	String	Connect to the Interbank API, make query and receive response

Parameter:

- url: the destination url to send the request
- data: the data of the request

Exception:

- UnrecognizedException: if responded with an unknown error code or something goes wrong

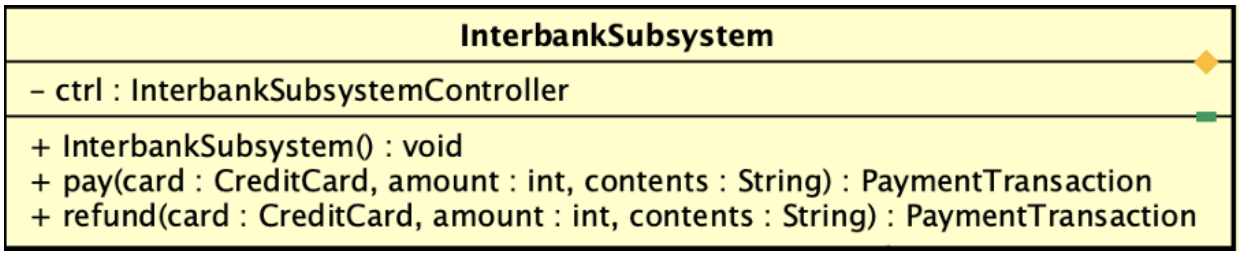
Method:

None

State:

None

4.4.3.11 Class "InterbankSubsystem"



Attribute

#	Name	Data Type	Default Value	Description
1	ctrl	InterbankSubsystemController		Represent the controller of the system

Operation

#	Name	Return Type	Description
1	InterbankSubsystem		Create a new InterbankSubsystem with its InterbankSubsystemController
2	pay	PaymentTransaction	Pay rent, then return the payment transaction
3	refund	PaymentTransaction	Refund, then return the payment transaction

Parameter:

- card: the credit card used for payment/refund
- amount: the amount to pay/refund
- contents: the transaction contents

Exception:

- PaymentException: if responded with a pre-defined error code
- UnrecognizedException: if responded with an unknown error code or something

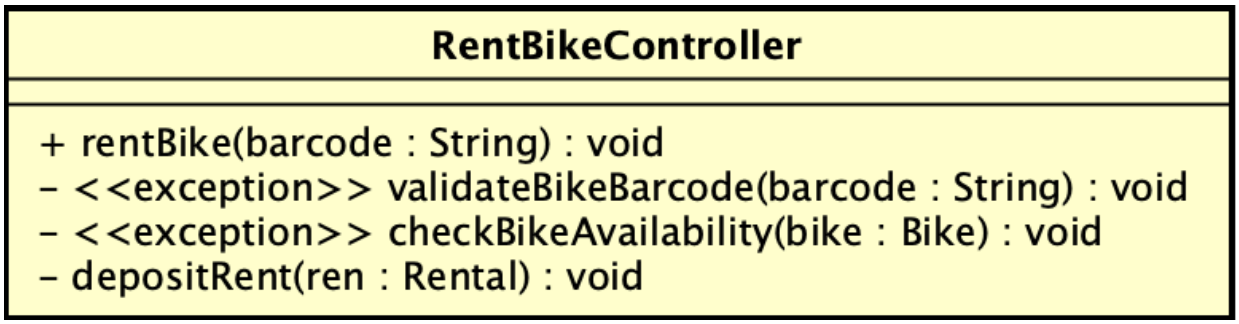
Method:

None

State:

None

4.4.3.12 Class "RentBikeController"



Attribute

None

Operation

#	Name	Return Type	Description
1	rentBike	Rental	Rent bike, and then return the corresponding rental

Parameter:

- barcode: the barcode of the bike
- rental: the rental information

Exception:

- InvalidBarcodeException: if the input barcode is not valid
- UnavailableBikeException: if the bike is not available for renting

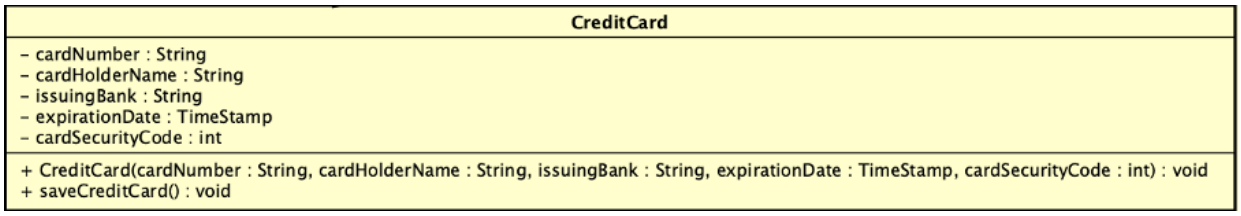
Method:

- validateBikeBarcode: validate the bike barcode from input
- checkBikeAvailability: check whether the bike is available for renting
- depositRent: deposit the initial renting fee

State:

None

4.4.3.13 Class "CreditCard"



Attribute

#	*Name*	*Data Type*	*Default Value*	*Description*
1	cardNumber	String		Controller of payment
2	cardHolderName	String		Number of card
3	issuingBank	String		Holder name of card
4	expirationDate	Timestamp		Security code of card
5	cardSecurityCode	int		

Operation

#	*Name*	*Return Type*	*Description*
1	CreditCard	Invoice	Create credit card instance
2	saveCreditCard		Save the card information

Parameter:

- cardNumber
- cardHolderName
- issuingBank
- expirationDate
- cardSecurityCode

Exception:

None

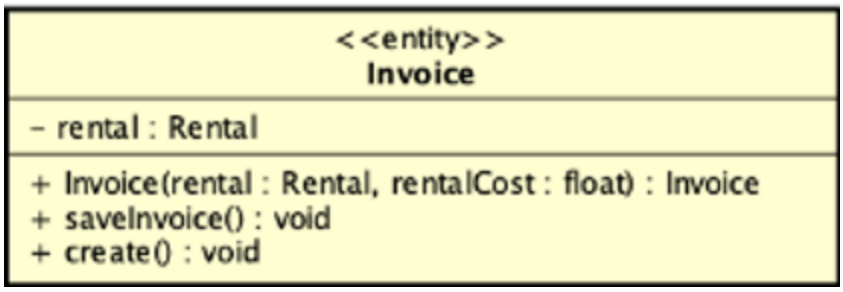
Method:

None

State:

None

4.4.3.14 Class "Invoice"



Attribute

#	*Name*	*Data Type*	*Default Value*	*Description*
1	cardNumber	String		Controller of payment

Operation

#	*Name*	*Return Type*	*Description*
1	Invoice	Invoice	Create invoice instance

2	saveInvoice	void	Save the invoice information
3	create	void	Create invoice instance with default value

Parameter:

- rental: rental linked to invoice instance
- rentalCost: cost of rental to add to invoice

Exception:

None

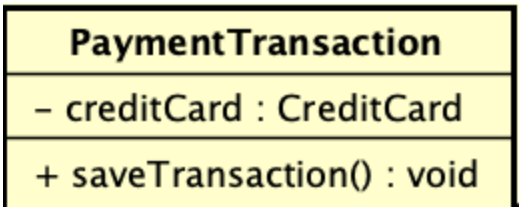
Method:

None

State:

None

4.4.3.15 Class "PaymentTransaction"



Attribute

#	*Name*	*Data Type*	*Default Value*	*Description*
1	creditCard	CreditCard	null	Represent the credit card used in this PaymentTransaction

Operation

#	*Name*	*Return Type*	*Description*
1	saveTransaction	void	Save the transaction

Parameter:

None

Exception:

None

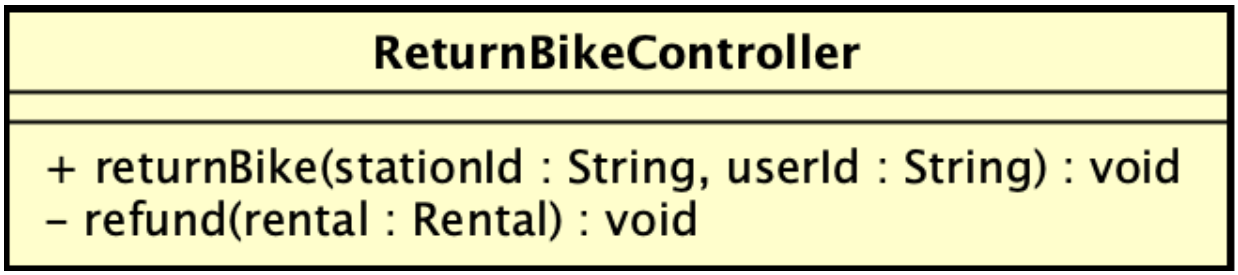
Method:

None

State:

None

4.4.3.16 Class "ReturnBikeController"



Attribute

None

Operation

#	*Name*	*Return Type*	*Description*
1	refund	void	Confirm payment

2	renturnBike	void	Proceed rent bike

Parameter:

None

Exception:

None

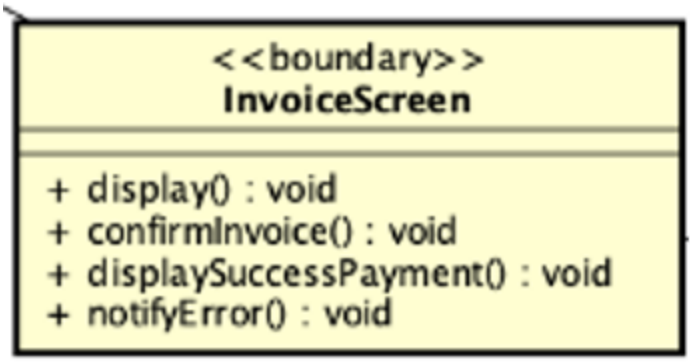
Method:

None

State:

None

4.4.3.17 Class "InvoiceScreen"



Attribute

None

Operation

#	*Name*	*Return Type*	*Description*
1	display	void	Display invoice page UI
2	confirmInvoice	void	Confirm selected invoice

3	displaySuccessPayment	void	Display payment information after invoice is proceeded
4	notifyError	void	Notify error when proceeding

Parameter:

None

Exception:

None

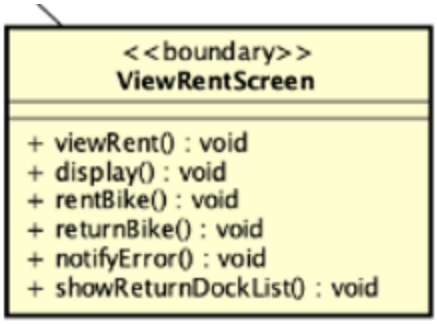
Method:

None

State:

None

4.4.3.18 Class "ViewRentScreen"



Attribute

None

Operation

#	*Name*	*Return Type*	*Description*

1	viewRent	void	Display rent information
2	display	void	Display view rent screen UI
3	returnBike	void	Return currently renting bike
4	rentBike	void	Rent selected bike
5	notifyError	void	Notify error when processing rent or return bike
6	showReturnDockList	void	Display available dock to return bike

Parameter:

None

Exception:

None

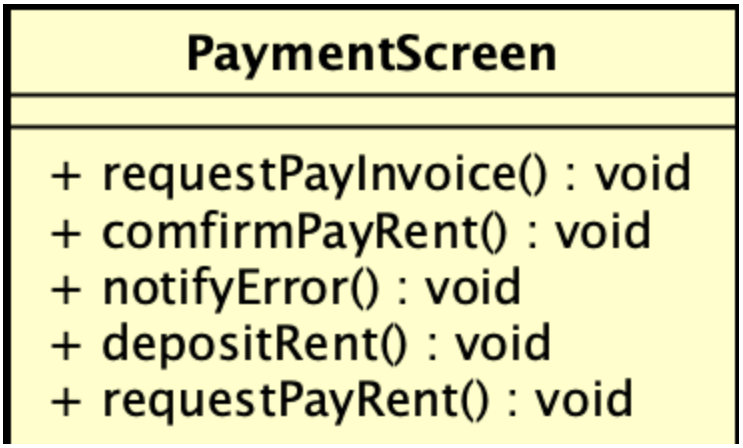
Method:

None

State:

None

4.4.3.19 Class "PaymentScreen"



Attribute

None

Operation

#	*Name*	*Return Type*	*Description*
1	requestPayInvoice	void	Start paying invoice processing
2	confirmPayRent	void	Process pay rent with current rent information
3	notifyError	void	Display error from processing
4	depositRent	void	Deposit an amount from user account
5	requestPayRent	void	Start processing current info to display rent

Parameter:

None

Exception:

None

Method:

None

State:

None

4.4.3.20 Class "ViewStationListController"

Attribute

None

Operation

#	*Name*	*Return Type*	*Description*
1	getStationList	void	Get list of stations

Parameter:

None

Exception:

None

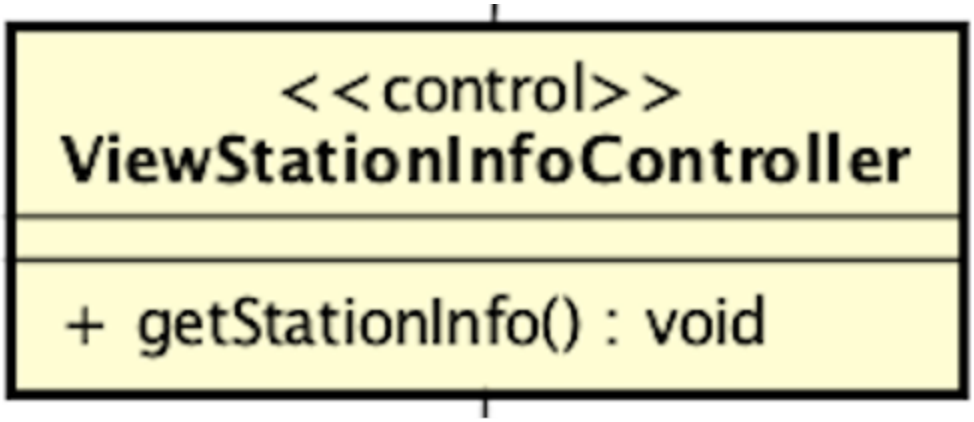
Method:

None

State:

None

4.4.3.21 Class "ViewStationInfoController"



Attribute

None

Operation

#	Name	Return Type	Description
1	getStationInfo	void	Get info of the current station

Parameter:

None

Exception:

None

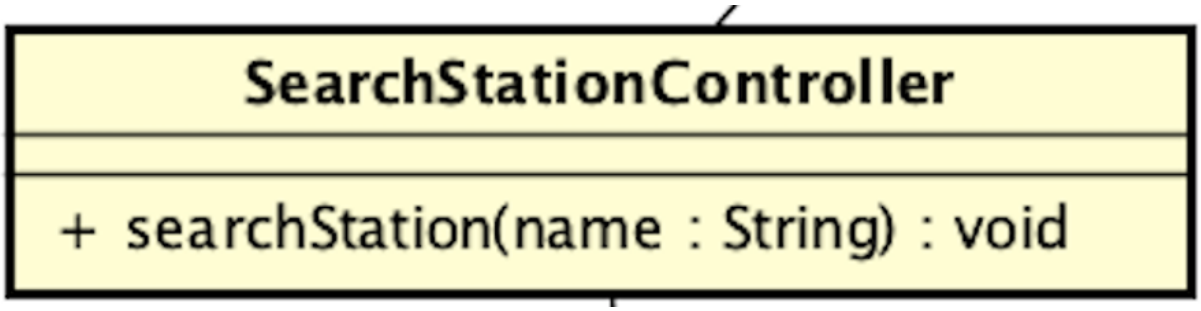
Method:

None

State:

None

4.4.3.22 Class "SearchStationController"



Attribute

None

Operation

#	Name	Return Type	Description
1	searchStation	void	Search for a station by its name

Parameter:

- name - String: name of the station you want to search for

Exception:

None

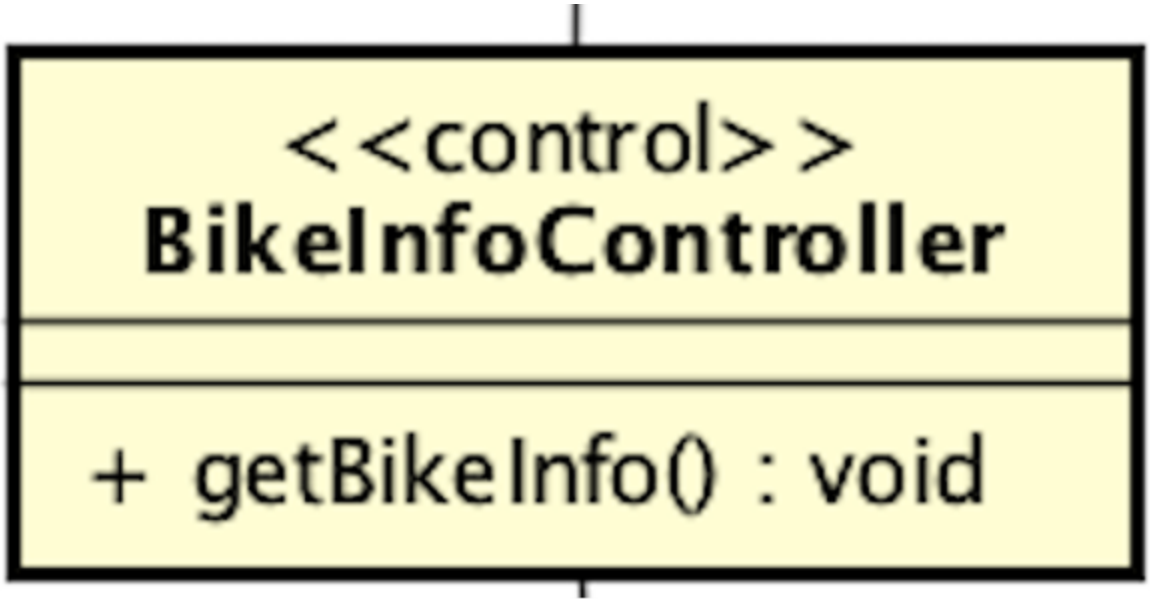
Method:

None

State:

None

4.4.3.23 Class "ViewBikeInfoController"



Attribute

None

Operation

#	Name	Return Type	Description
1	getBikeInfo	void	Get info of the current bike

Parameter:

None

Exception:

None

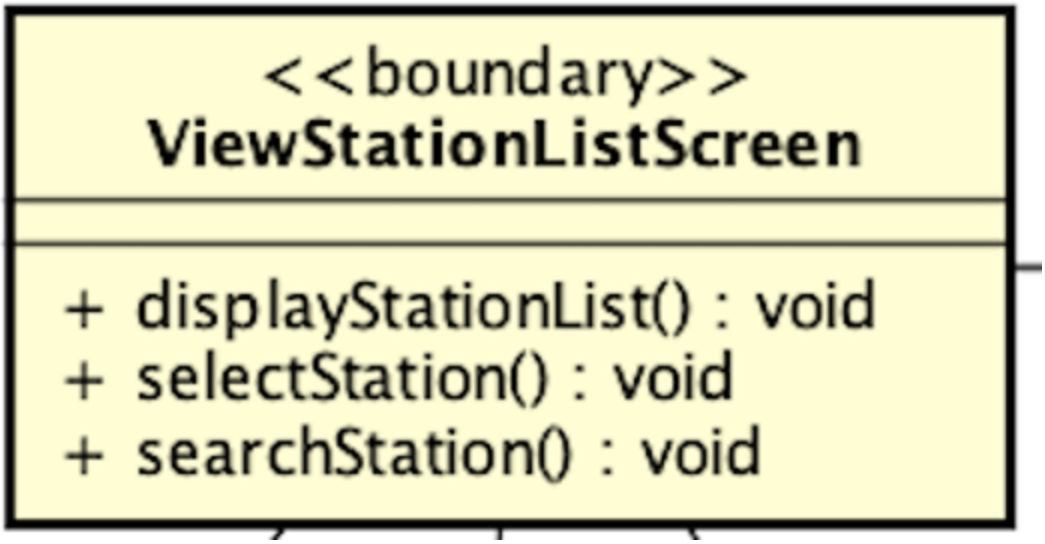
Method:

None

State:

None

4.4.3.24 Class "ViewStationListScreen"



Attribute

None

Operation

#	*Name*	*Return Type*	*Description*
1	selectStation	void	Select a station from the list
2	searchStation	void	Call SearchStationController to search station by name or address
3	displayStationList	void	Display passed list of stations

Parameter:

None

Exception:

None

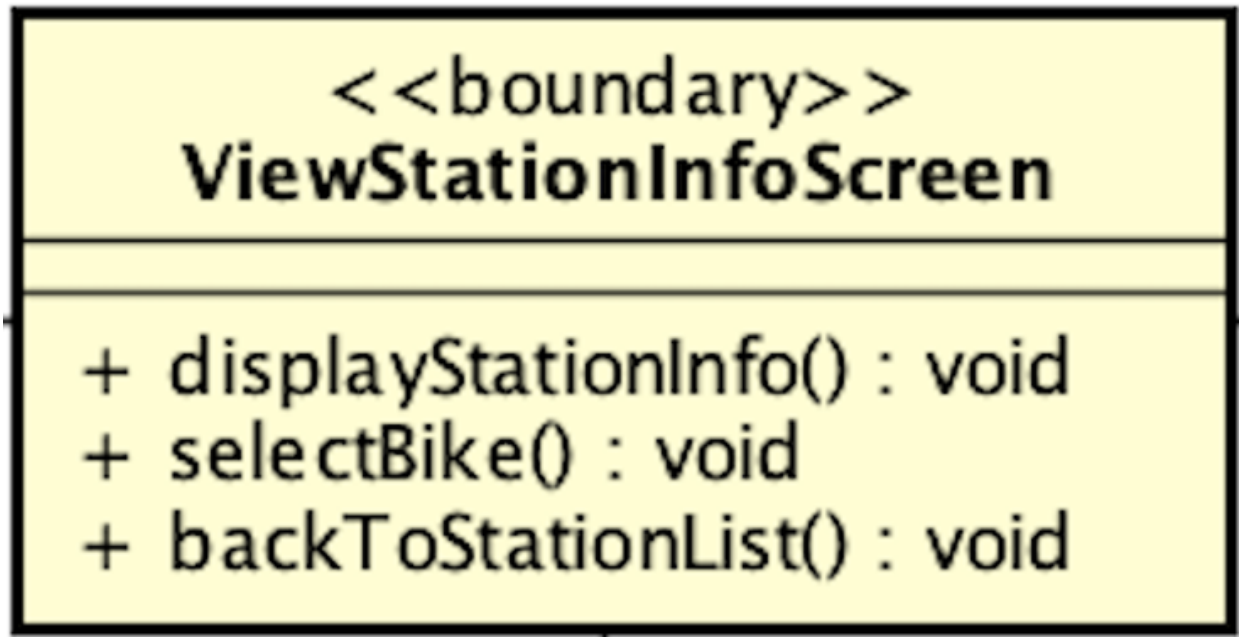
Method:

- selectStation: Get station from user selection and call getStationInfo() in ViewStationInfoController to display station info in ViewStationInfoScreen
- searchStation: Input a name and search for a station using the searchStation() in SearchStationController

State:

None

4.4.3.25 Class "ViewStationInfoScreen"



Attribute

None

Operation

#	*Name*	*Return Type*	*Description*

1	displayStationInfo	void	Display the info of the current station
2	selectBike	void	Select a bike from the list
3	backToStationList	void	Back to the previous station list screen

Parameter:

None

Exception:

None

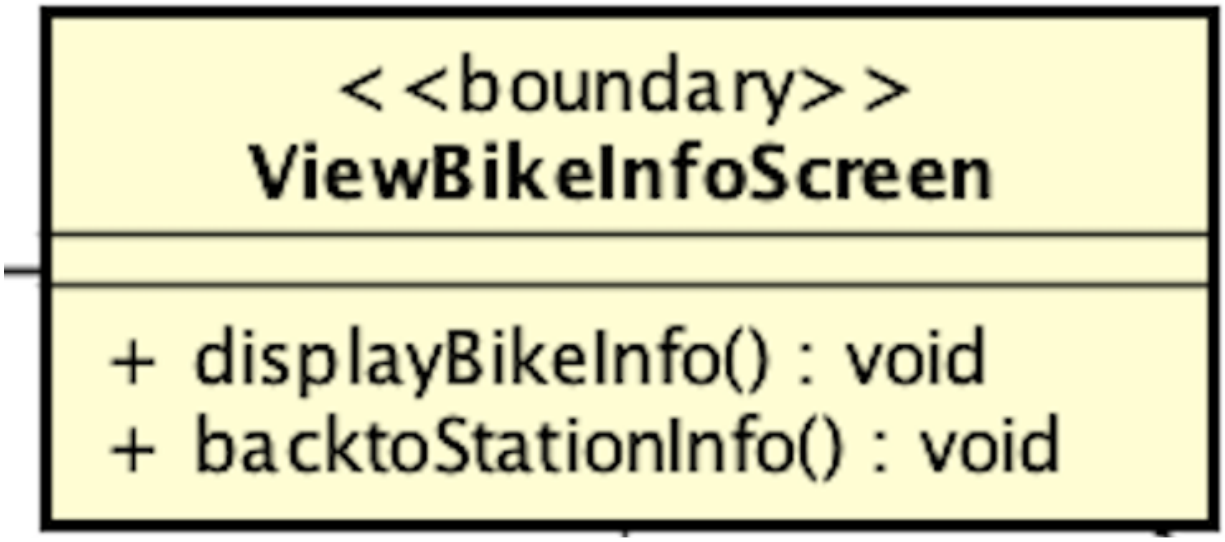
Method:

- selectBike: Get bike from user selection and call getBikeInfo() in ViewBikeInfoController to display bike info in ViewBikeInfoScreen

State:

None

4.4.3.26 Class "ViewBikeInfoScreen"



Attribute

None

Operation

#	*Name*	*Return Type*	*Description*
1	displayBikeInfo	void	Display the information of the current bike
2	backToStationInfo	void	Return to the previous station info screen

Parameter:

None

Exception:

None

Method:

None

State:

None

4.4.3.27 Class "Bike"

Attribute

#	Name	Data Type	Default Value	Description
1	bikeCode	int	NULL	Code of the bike in the system

2	licensePlate	String	NULL	License plate of the bike
3	isLocked	boolean	True	Lock condition of the bike
4	saddle	int	NULL	Number of saddles
5	pedal	int	NULL	Number of pedals
6	rearSeat	int	NULL	Number of rear seats
7	rentRate	float	NULL	Rate of the rent price
8	deposit	int	NULL	The deposit amount needed to rent the bike
9	battery	int	100	Percentage of battery left

Operation

#	Name	Return Type	Description
1	getBikeCode	int	Get the code of the bike
2	getLicensePlate	String	Get the license plate of the bike
3	getSaddle	int	Get number of saddles of the bike

4	getPedal	int	Get number of pedals of the bike
5	getRearSeat	int	Get number of rear seats of the bike
6	getRentRate	float	Get rentRate of the bike
7	getDeposit	int	Get deposit of the bike
8	setDeposit	void	Set the deposit of the bike
9	setRentRate	void	Set the rentRate of the bike
10	getBikeType	String	Get the type of the bike
11	isAvailable	boolean	Check the available condition of the bike
12	getBattery	int	Get the percentage of battery left
13	estimateTimeLeft	int	Get the number of minutes left the electric bike can run

Parameter:

None

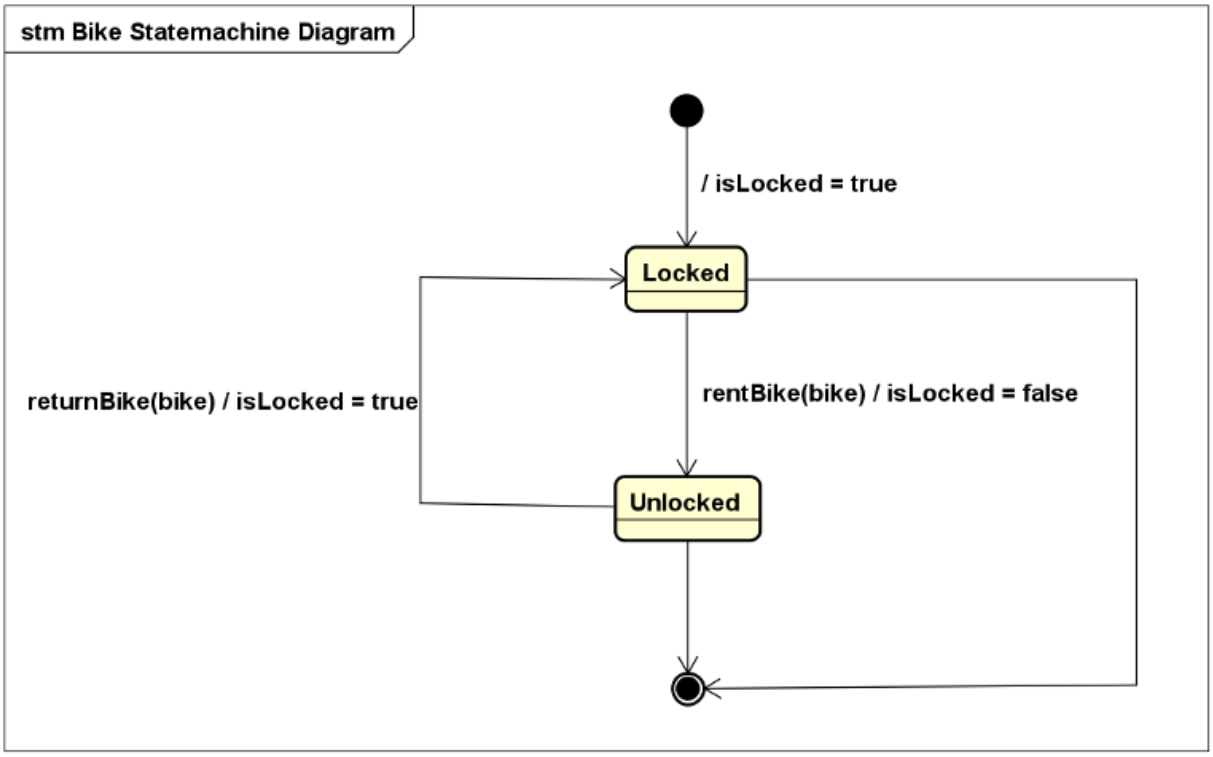
Exception:

None

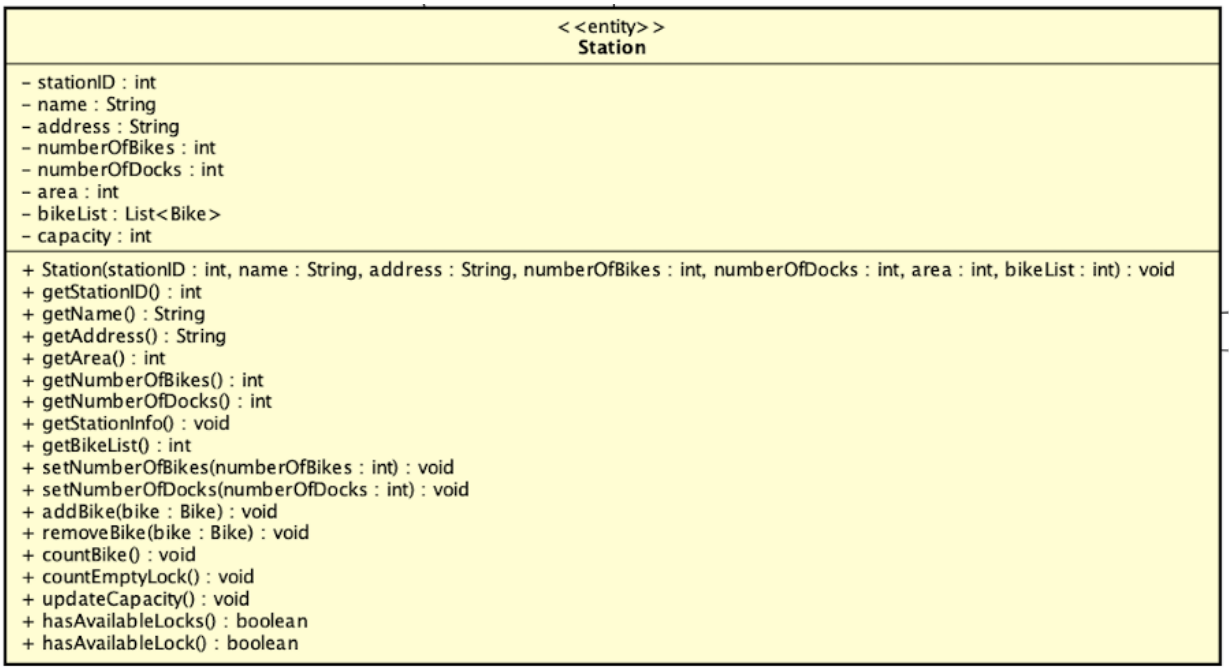
Method:

None

State:



4.4.3.28 Class "Station"



Attribute

#	Name	Data Type	Default Value	Description
1	stationID	int	NULL	ID of the station in the system
2	name	String	NULL	Name of the station
3	address	String	NULL	Address of the station
4	numberOfBikes	int	NULL	Number of bikes currently in the station
5	numberOfDocks	int	NULL	Number of docks in the station
6	area	int	NULL	Area size of the station
7	bikeList	List<Bike>	NULL	List of the bikes currently in the station
8	capacity	int	NULL	The number of available docks left in the station

Operation

#	Name	Return Type	Description

1	getStationID	int	Get the stationID
2	getName	String	Get the name of the station
3	getAddress	String	Get the address of the station
4	getNumberOfBikes	int	Get the number of bikes currently in the station
5	getNumberOfDocks	int	Get the number of docks in the station
6	getBikeList	List <Bike>	Get the list of bikes currently in the station
7	addBike	Bike	Add a bike to the list of bikes currently in the station
8	removeBike	Bike	Remove of bike from the list of bikes currently in the station
9	updateCapacity	void	Update the capacity of the station according to numberOfBikes and numberOfDocks

Parameter:

- bike – Bike: A particular bike object
- rentalCode – String: code given by the system when user successfully rents a bike and can be used for other purposes
- barcode – String: Unique code of each bike in String format

Exception:

None

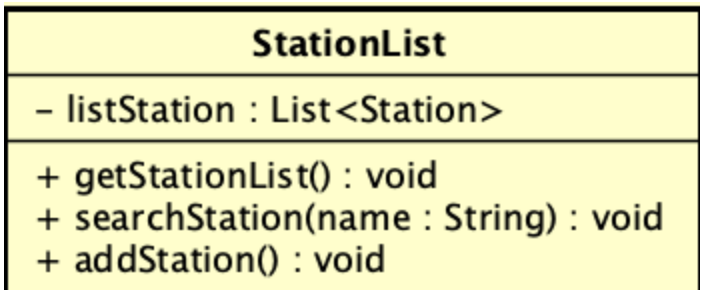
Method:

None

State:

None

4.4.3.29 Class "StationList"



Attribute

#	Name	Data Type	Default Value	Description
1	listStation	List<Station>	NULL	List of the stations

Operation

#	Name	Return Type	Description
1	getStationList	List<Station>	Get list of the stations
2	searchStation	Station	Search for a station by its name

3	addStation	void	Add a new station to the list

Parameter:

- name – String: Name of station
- station – Station: The station you want to add

Exception:

None

Method:

None

State:

None

5 Design Considerations

<Describe issues which need to be addressed or resolved before attempting to devise a complete design solution>

5.1 Goals and Guidelines

5.1.1 Goals

The project was designed with simplicity and reliability in mind. This means that the program would be easily accessible and guaranteed to deliver all the requirements. However, it should not be only plain and boring. The application should bring a pleasant experience for the users and also attract other new customers for the business.

5.1.2 Guidelines

5.2 Architectural Strategies

<Describe any design decisions and/or strategies that affect the overall organization of the system and its higher-level structures. These strategies should provide insight into the key abstractions and mechanisms used in the system architecture. Describe the reasoning employed for each decision and/or strategy (possibly referring to previously stated design goals and principles) and how any design goals or priorities were balanced or traded-off.

Examples of design decisions might concern (but are not limited to) things like the following:

- *Use of a particular type of product (programming language, database, library, commercial off-the-shelf (COTS) product, etc.)*
- *Reuse of existing software components to implement various parts/features of the system*
- *Future plans for extending or enhancing the software*
- *User interface paradigms (or system input and output models)*
- *Hardware and/or software interface paradigms*
- *Error detection and recovery*
- *Memory management policies*
- *External databases and/or data storage management and persistence*
- *Distributed data or control over a network*

- *Generalized approaches to control*
- *Concurrency and synchronization*
- *Communication mechanisms*
- *Management of other resources*

>

- In this project, the programming language chosen is Java as it's taught in the course and also provides good support for the OOP paradigm.
- For the GUI, we use JavaFX as the framework provides an easy interface for UI design and integration with the code controller.
- The database is hosted using MySQL as the DBMS.

5.3 Coupling and Cohesion

<Evaluate your design and describe which levels of coupling and cohesion that your design is at. Give proofs for your assumptions. Explain if there is any special design or exceptions>

5.4 Design Principles

<Does your design follow the SOLID principles for the new requirements/changing requirements? Give proofs for your assumptions. Explain if there is any special design or exceptions>

5.5 Design Patterns

<Do you use any design patterns for your design? If yes, describe detailly why you use those design patterns? Describe in detail on the solutions and how to implement each design pattern>