MINISTRY OF EDUCATION AND TRAINING

FPT UNIVERSITY

Report 3

Parking Guidance System Solution

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Capstone Project Code	PGSS

- Ho Chi Minh City, Jan, 2017

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Definitions, Acronyms and Abbreviations

Name	Definition
PGS	Parking Guidance System
Parking area	An area set aside for parking vehicles, aircraft, etc.
Parking lot	A place inside parking area that provide space for one vehicle
IoT	Internet of Things
CCU	Central Control Unit

Table 1: Definitions, Acronyms and Abbreviations

C. Software – Hardware Requirement Specification

1. Software Requirement Specification

1.1. Software Requirement

Manager can show the information of their car park to the end user, which will increase the interaction between car park provider and end user. The information include:

- Address
- Contact info
- Number of empty parking lot

End user can find the nearest car park, which has empty parking lot.

Manager can manage their car park easily; make an automatic system to guide the end user base on the interaction panel, which show number of empty parking lot in each area and the status light on each parking lot.

Users can see empty slot and detail information about parking area by touching a marker on map.

User can reserve a parking slot.

1.2. GUI Requirement

User interface of mobile app must be simple, clearly and easy to use.

The color of mobile app must be elegant, not garish.

Each UI element must be arranged logically, allowing user access easily.

Meet all main function requirements.

2. Hardware Requirement Specification

2.1. Hardware Requirement

2.1.1. Hardware Interface

The hardware interface must satisfied the following requirements:

- Easy to replace
- Low-cost module
- Easy to implement

Based on project requirement we have choose following hardware components.

2.1.1.1. Block Diagram

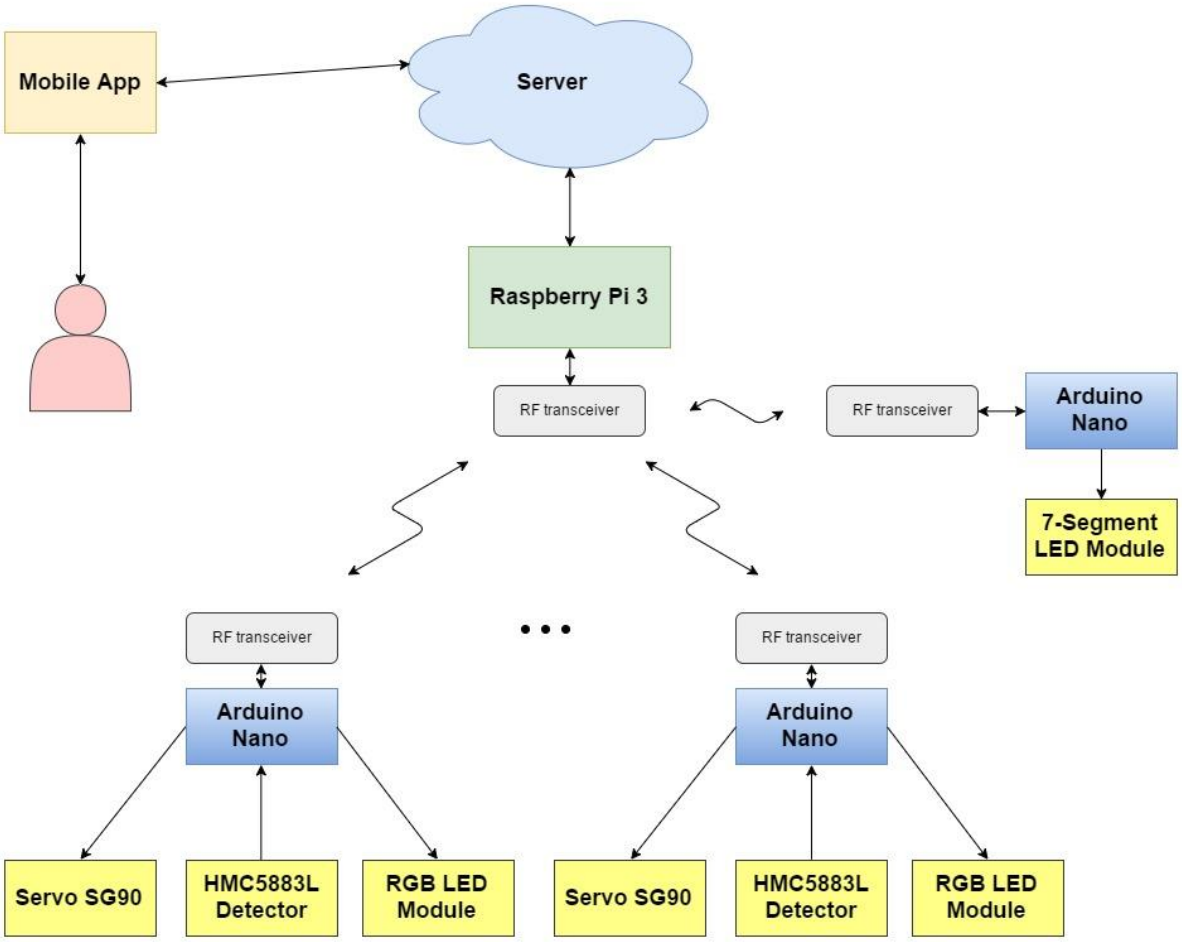

Figure 1: PGSS Block Diagram

2.1.1.2. Raspberry Pi 3

Figure 2: Raspberry Pi 3

Overview: To communicate with all other hardware component and processing value, we must have a Central control unit, there are many kind of central control unit in the market. After evaluate requirement of project, we decide to choose Raspberry Pi 3. Raspberry Pi 3 is powerful mini-computer with many features.

Specification:

SoC	Broadcom BCM2837
CPU	4× ARM Cortex-A53, 1.2GHz
GPU	Broadcom VideoCore IV
RAM	1GB LPDDR2 (900 MHz)
Network	10/100 Ethernet, 2.4GHz 802.11n wireless
Bluetooth	Bluetooth 4.1 Classic, Bluetooth Low Energy
Storage	microSD
GPIO	40

Table 2: Raspberry Pi 3 – Specification

More details about Raspberry Pi 3:

https://www.raspberrypi.org/products/raspberry-pi-3-model-b/

2.1.1.3. Arduino Nano

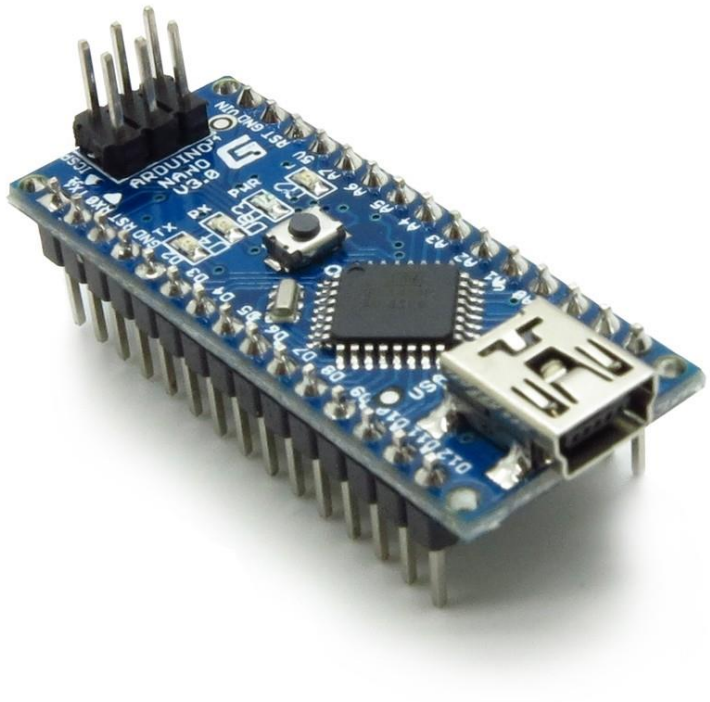

Figure 3: Arduino Nano

Overview: The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328 (Arduino Nano 3.x).

Specification:

Microcontroller	ATmega328
Architecture	AVR
Operating Voltage	5 V
Flash Memory	32 KB of which 2 KB used by bootloader
SRAM	2 KB
Clock Speed	16 MHz

Analog I/O Pins	8
EEPROM	1 KB
DC Current per I/O Pins	40 mA (I/O Pins)
Input Voltage	7-12 V
Digital I/O Pins	22
PWM Output	6
Power Consumption	19 mA
PCB Size	18 x 45 mm
Weight	7 g
Product Code	A000005

Table 3: Arduino Nano - Specification

More detail about Arduino Nano:

https://www.arduino.cc/en/Main/arduinoBoardNano

2.1.1.4. Compass Module 3-Axis HMC5883L

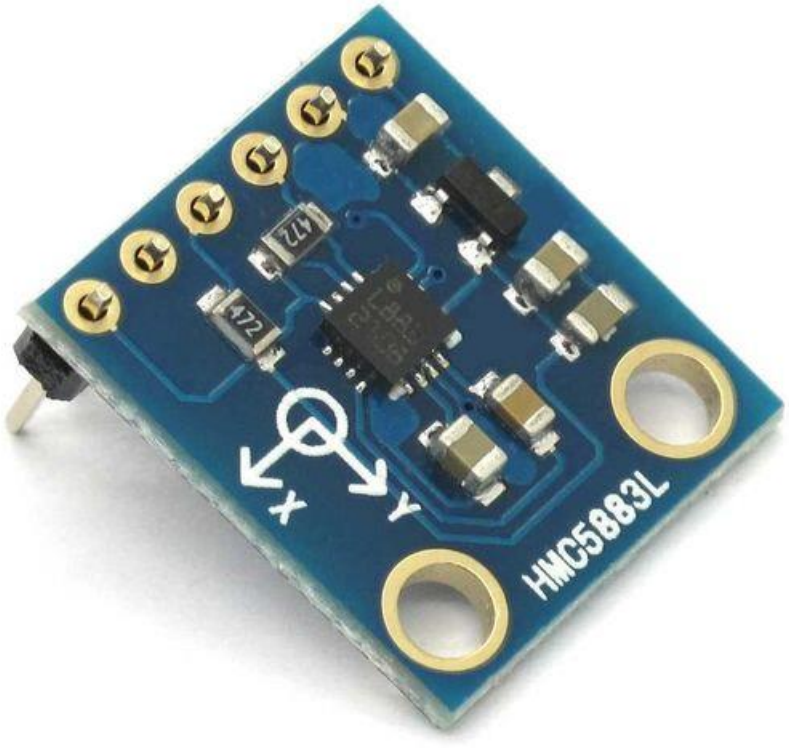

Figure 4: Compass Module 3-Axis HMC5883L

Overview: For detecting obstacle, we choose The Compass Module 3-Axis HMC5883L

instead of ultrasonic sensor because ultrasonic sensor has many weaknesses, they are not accuracy, cannot be used outdoor in the bad weather in Vietnam.

The Compass Module 3-Axis HMC5883L is a low-field magnetic sensing device with a digital interface.

We choose The Compass Module 3-Axis HMC5883L because:

- It has reasonable price.
- Compatible with arduino and other board.
- Compact size.

Specification:

Input and Output Pins:

Pin		I/O	Function
Name	No.		
VIN	1		Supply Voltage – 2.7 to 6.5 VDC
GND	2		Ground
SCL	3	I	I^2C Clock
SDA	4	IO	I^2C Data
RDY	5	I	Data Ready

Table 4: The Compass Module 3-Axis HMC5883L - Pin Function

2.1.1.5. RF module nRF24L01+

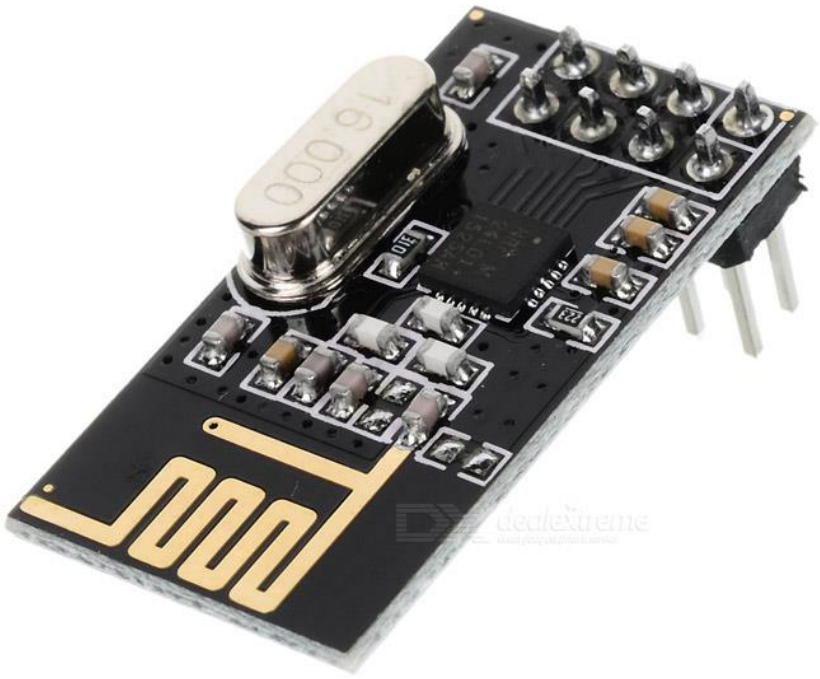

Figure 5: RF module nRF24L01+

Overview: Reason for PGSS use RF module nRF24L01 to communicate between Central control unit and other hardware component:

- It has reasonable price.
- Easy to buy.
- Ultra low power consumption.

Specification:

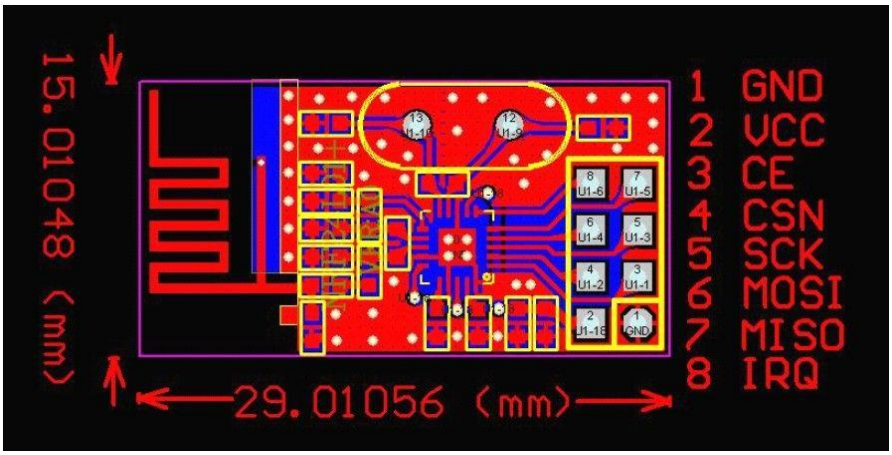

Figure 6: RF module nRF24L01+ - Specification

Pin		I/O	Description
No.	Name		
1	GND		Power Supply Ground
2	VCC		3.3V
3	CE	I	Chip Enable
4	CSN	I	SPI Chip Select
5	SCK	I	SPI Clock
6	MOSI	I	SPI Slave Data Input
7	MISO	O	SPI Slave Data Output
8	IRQ	O	Maskable Interrupt Pin

Table 5: RF Module nRF24L01 – Pin function

2.1.1.6. Information LED Display Module

Information LED Display Module include: 7-segment LED Display, TPIC6B595 Power Logic 8-Bit Shift Register

7-segment LED Display

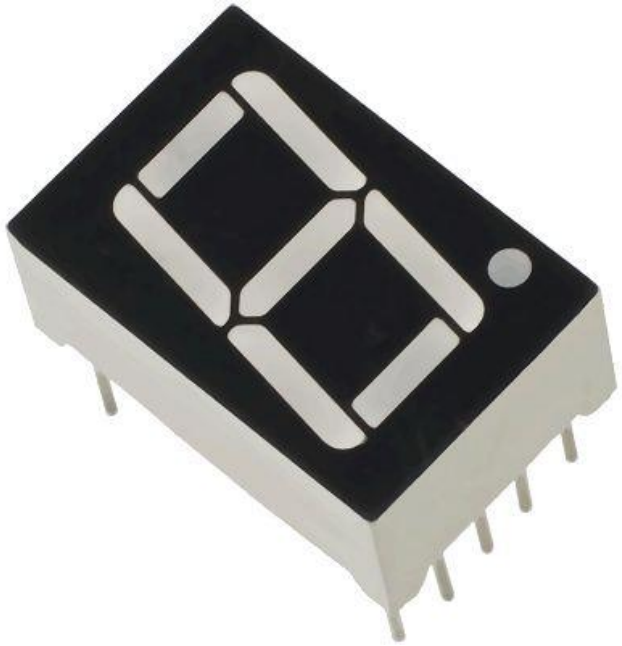

Figure 7: 7-segment LED Display

Specification:

- 0.56 inch digit height
- Super Red emitting color
- White segment color, gray face
- Low current operation
- Easy mounting on PCB boards or sockets

TPIC6B595 Power Logic 8-Bit Shift Register

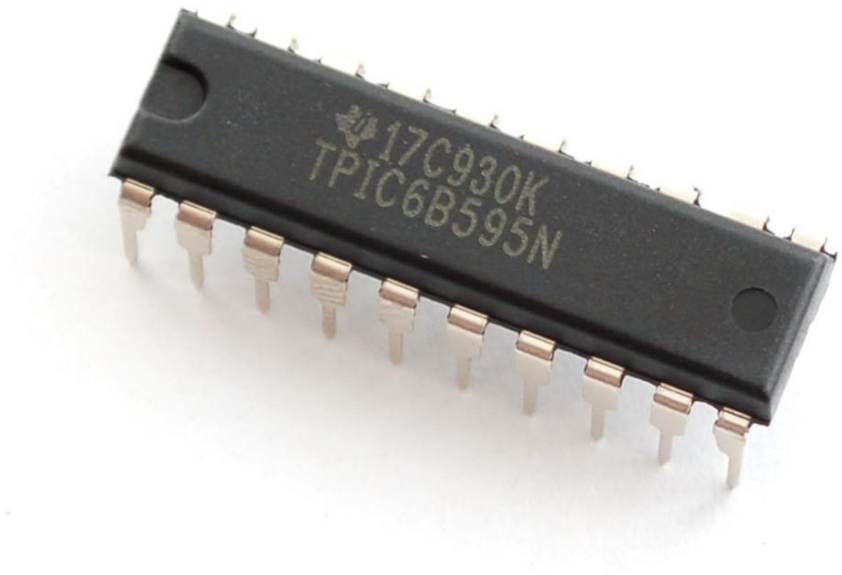

Figure 8: TPIC6B595 Power Logic 8-Bit Shift Register

Specification:

To display high power 7-segment display, we choose IC TPIC6B595 instead of IC 74HC595 because TPIC6B595 is a simple shift register IC that can control high-voltage/high-current devices directly**.** Each output pin can sink 150mA and then supports the maximum of Load Voltage at 50V.

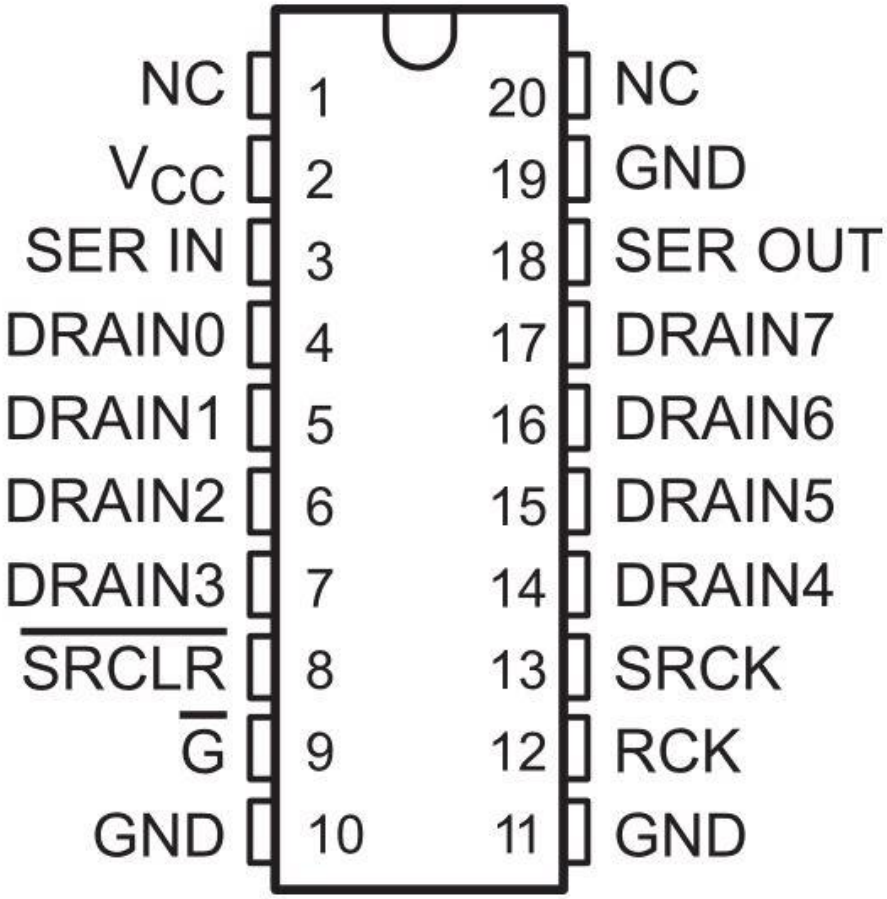

Figure 9: TPIC6B595 Pin-outs

Pin		I/O	Description
Name	**No.**		
DRAIN0	4	O	Open-drain output
DRAIN1	5		
DRAIN2	6		
DRAIN3	7		
DRAIN4	14		
DRAIN5	15		
DRAIN6	16		
DRAIN7	17		
G	9	I	Output enable, active-low

GND	10,11,19	-	Power ground
NC	1, 20	-	No internal connection
RCK	12	I	Register clock
SERIN	3	I	Serial data input
SEROUT	18	O	Serial data output
SRCK	15	I	Shift register clock
SRCLR	8	I	Shift register clear, active-low
VCC	2	I	Power supply

Table 6: IC TPIC6B595 - Pin Function

2.1.1.7. Indicator LED Module

Indicator LED Module include: Common anode RGB LED, TIP122 Transistor

RGB LED common anode

Figure 10: RGB LED common anode

Overview:

RGB LED allows you to change the lights to any color to show state of parking slot.

Specification:

- Forward Voltage (RGB): (2.0, 3.2, 3.2)V
- Max Forward Current (RGB): (20, 20, 20)mA
- Max Luminosity (RGB): (2800, 6500, 1200)mcd

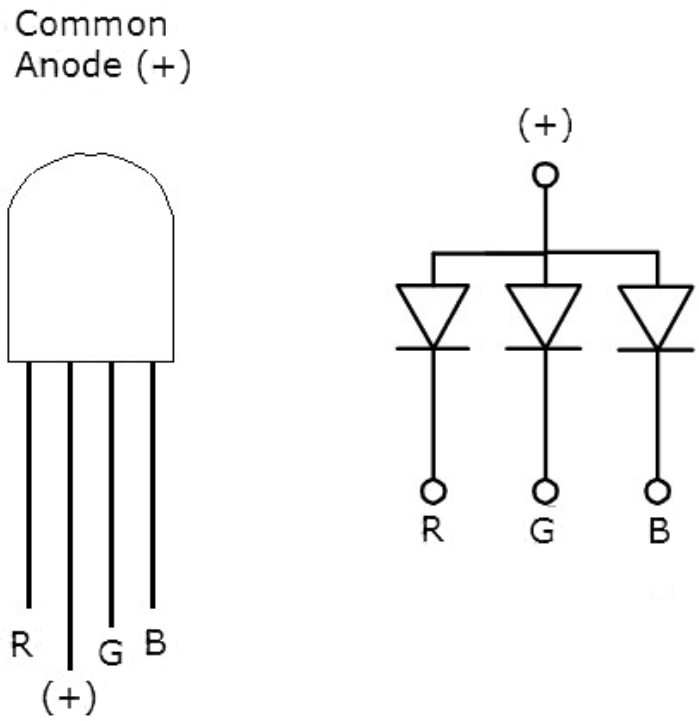

Figure 11: RGB LED common anode pin-out

TIP122 Transistor

Figure 12:: TIP122 Transistor

Overview: A single digital pin on Arduino Nano do not provide enough current to power RGB LED, A solution for this situation is to use an NPN Darlington Transistor designed for medium power linear switching applications, so we use TIP122 Transistor to provide RGB LED with power from an external source. It can power devices up to 100VDC at 5 Amps.

Specification:

- TIP122 is power transistors
- Collector Current: 5 ampere
- Collector-Emitter Volt: 100 volts
- Power Dissipation: 65 watts

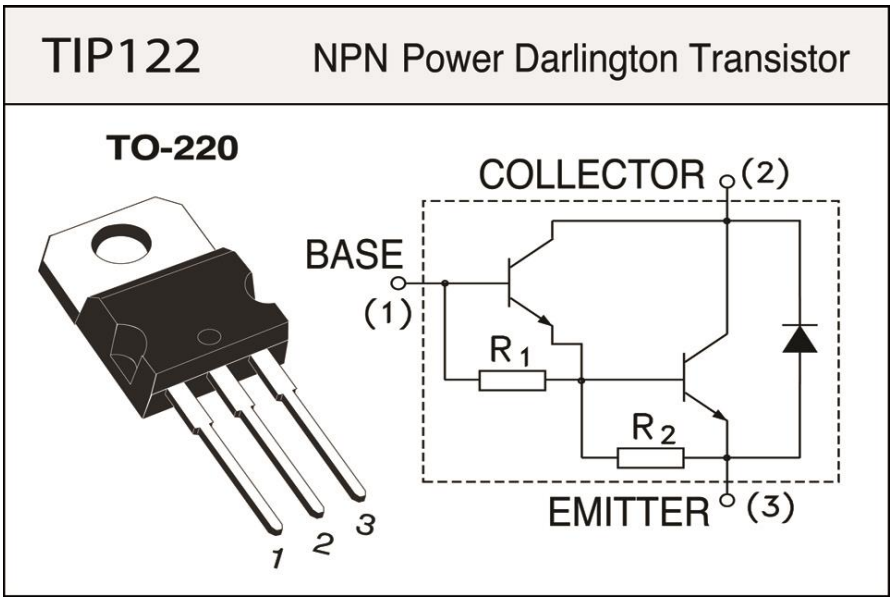

Figure 12: TIP122 Transistor- Pin Layout

2.1.1.8. Servo Motor SG90

Figure 13:: Servo Motor – Tower Pro SG90

Overview: PGSS use Servo Motor SG90 to control barrier at each parking slot.

Specification:

Torque	1.80 kg-cm at 4.8V
Speed	0.1sec/60° at 4.8V
Voltage	4.0V to 7.2V, 4.6V - 5.2V nominal
Dimensions	23mm x 12.2mm x 29mm
Rotation range	180º
Weight	9g
Pulse width	500-2400uS
Operating Temperature range	30°C to 60°C

Table 7: Servo Motor SG90 – Specification

Pin of Servo SG90	Name	Description
Red	VCC	Power supply 5V
Black	GND	Power supply ground
Yellow	Signal	The servo will move based on the signal sent to signal wire.

Table 7: Servo Motor SG90 – Pin-outs

2.1.2. Communication Protocol

- We communicate between hardware component and board through GPIO pin.
- Arduino Nano board communicate with Raspberry Pi 3 via RF Module.

2.2. System Overview Use Case

Figure 123: Overview use case diagram

2.3. List of Use Case

2.3.1. Manager Use Case

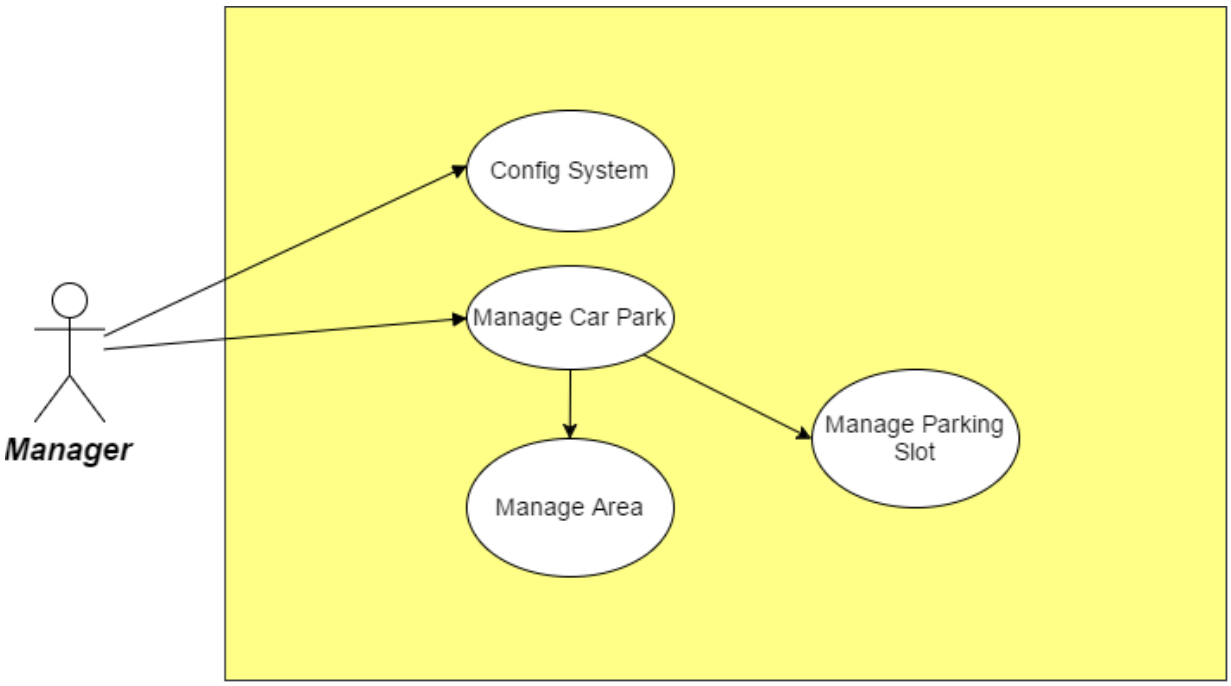

Figure 14: Manager Use case diagram

Use case specifications

Use Case-1 specification			
Use-case no.	PGSS01	**Use-case version**	1.0
Use-case name	Configuration System		
Author	Bui Phu Hiep		
Date	13/02/17	**Priority**	High

Actor:
- Manager

Summary:
- This use case allow user to change the configuration of their system.

Goal:
- Manager can change the information of car park, which show to the end user.

Triggers:
- User click on “Setting” button.

Preconditions:
- Mobile application is already launch.
- Manager has been logged in

Post Conditions:
- **On Success:** New configuration is apply and save to server
- **On Failure:** Show error message

Main Success Scenario:

No.	Actor Action	System Response
1	User click on “Setting” button	Application navigate to “Setting” menu
2	User select option in the Menu Change by click toggle or change value in the text box Select “Submit” button	Change the value and save to server

Alternative Scenario:
- N/A

Exceptions:
- N/A

Business Rules:
- N/A

Use Case-2 specification			
Use-case no.	PGSS02	**Use-case version**	1.0
Use-case name	Manage Car Park		
Author	Bui Phu Hiep		
Date	13/02/17	**Priority**	High

Actor:
- Manager

Summary:
- This use case allow user to change their car park info.

Goal:
- Manager can change the information of car park, which show to the end user.

Triggers:
- User select their car park.
- Click “Edit”

Preconditions:
- Mobile application is already launch.
- Manager has been logged in

Post Conditions:
- **On Success:** New information of edited car park saved to server.
- **On Failure:** Show error message

Main Success Scenario:

No.	Actor Action	System Response
1	User select car park. User click on “Edit” button	Application navigate to “Setting” menu
2	User select option in the Menu Change by click toggle or change value in the text box	

	Select "Submit" button	Change the value and save to server

Alternative Scenario:
- N/A

Exceptions:
- N/A

Business Rules:
- N/A

Use Case-3 specification			
Use-case no.	PGSS03	**Use-case version**	1.0
Use-case name	Manage Area		
Author	Bui Phu Hiep		
Date	13/02/17	**Priority**	High

Actor:
- Manager

Summary:
- This use case allow user to change the status of each area.

Goal:
- The status of selected area updated and change in mobile app.

Triggers:
- User select their car park.
- User select area in selected car park.

Preconditions:
- Mobile application is already launch.
- Manager has been logged in

Post Conditions:
- **On Success:** New configuration is apply and save to server
- **On Failure:** Show error message

Main Success Scenario:

No.	Actor Action	System Response
1	User select car park	Application change to car park detail page
2	User select area in the selected car park	Application change to area detail page
3	User select status in the drop down list. Click "Update" button	The status of the area will change on server and update in mobile application

Alternative Scenario:
- N/A

Exceptions:
- N/A

Business Rules:
- N/A

Use Case-4 specification			
Use-case no.	PGSS04	**Use-case version**	1.0
Use-case name	Manage Parking Slot		
Author	Bui Phu Hiep		
Date	13/02/17	**Priority**	High

Actor:
- Manager

Summary:
- This use case allow user to manage the parking slot.

Goal:
- The status of selected area updated and change in mobile app.

Triggers:
- User select their car park.
- User select area in selected car park.
- Then select parking slot

Preconditions:
- Mobile application is already launch.
- Manager has been logged in

Post Conditions:
- **On Success:** New configuration is apply and save to server
- **On Failure:** Show error message

Main Success Scenario:

No.	Actor Action	System Response
1	User select car park	Application change to car park detail page
2	User select area in the selected car park	Application change to area detail page
3	User select parking slot to edit After change information, select "Update" button	The information of parking slot is change on server and update in mobile application.

Alternative Scenario:

No.	Actor Action	System Response
1	User select car park	Application change to car park detail page
2	User select area in the selected car park	Application change to area detail page
3	User click menu beside list parking spot to delete.	The parking spot will be set to deleted in server and update in mobile app.

Exceptions:
- N/A

Business Rules:
- N/A

2.3.2. Administrator Use Case

Use Case-5 specification			
Use-case no.	PGSS05	**Use-case version**	1.0
Use-case name	Add Car Park		
Author	Bui Phu Hiep		
Date	13/02/17	**Priority**	High

Actor:
- Administrator

Summary:
- This use case allow user to add new car park to the system

Goal:
- New car park is added and save to server.

Triggers:
- User click on “Add” button.

Preconditions:
- Mobile application is already launch.
- Administrator has been logged in

Post Conditions:
- **On Success:** New car park is save to server
- **On Failure:** Show error message

Main Success Scenario:

No.	Actor Action	System Response
1	User click on “Add” or “+” button	Application navigate to add car park menu
2	User fill in the textbox	

	Select "Submit" button	New car park with filled in info is added to server

Alternative Scenario:
- N/A

Exceptions:
- Name of the car park is unique
- Address of the car park is unique (don't has same latitude and longitude)

Business Rules:
- N/A

2.3.3. End User Use Case

Use Case-6 specification			
Use-case no.	PGSS06	**Use-case version**	1.0
Use-case name	Check number of empty slot		
Author	Bui Phu Hiep		
Date	13/02/17	**Priority**	High

Actor:
- End User

Summary:
- This use case allow user view number of empty slot in each car park

Goal:
- Show number of empty slot

Triggers:
- User login to the mobile application

Preconditions:
- Mobile application is already launch.
- End user had logged in.

Post Conditions:
- **On Success:** User know the number of empty slot in car park
- **On Failure:** Don't show number of empty slot in car park

Main Success Scenario:

No.	Actor Action	System Response
1	User log in to the application	Show the map with the marker as car park and the number, which indicate the number of empty slot

Alternative Scenario:
- N/A

Exceptions:

- The number will have tick/ exclamation points to show that the number is recently update or not.

Business Rules:

- Tick: recently update
- Exclamation points: number is not update in more than 1 hour.

Use Case-7 specification			
Use-case no.	PGSS07	**Use-case version**	1.0
Use-case name	Book parking slot		
Author	Bui Phu Hiep		
Date	13/02/17	**Priority**	High

Actor:

- End User

Summary:

- This use case allow user to book parking slot before go to the car park

Goal:

- Book the parking slot before go to car park

Triggers:

- User has selected the car park to book

Preconditions:

- Mobile application is already launch.
- End user had logged in.

Post Conditions:

- **On Success:** User book the parking slot success
- **On Failure:** Show error message when book

Main Success Scenario:

No.	Actor Action	System Response
1	User log in to the application	Show the map with the marker as car park and the number, which indicate the number of empty slot
2	User select the car park they want to book	Show the “Book” button if has empty slot
3	Fill information for transaction Click “Submit”	Make a transaction and set one parking slot to booked Show the address of booked parking slot to the user

Alternative Scenario:

- N/A

Exceptions:
- Transaction fail by 3rd party.

Business Rules:
- N/A

Use Case-8 specification			
Use-case no.	PGSS08	**Use-case version**	1.0
Use-case name	Search car park		
Author	Bui Phu Hiep		
Date	13/02/17	**Priority**	High

Actor:
- End User

Summary:
- This use case allow user to search a car park by name or address

Goal:
- Show the searched car park

Triggers:
- User login to the mobile application

Preconditions:
- Mobile application is already launch.
- End user had logged in.

Post Conditions:
- **On Success:** Show the searched car park on the map if success
- **On Failure:** Show message error

Main Success Scenario:

No.	Actor Action	System Response
1	User log in to the application	Show the map with the marker as car park and the number, which indicate the number of empty slot
2	Enter the name or address in the search bar Press “Enter” or click “Search”	Find the car park base on name or address then focus on the map.

Alternative Scenario:

No.	Actor Action	System Response
1	User log in to the application	Show the map with the marker as car park and the number, which indicate the number of empty slot
2	Enter the name or address in the search bar	

	Press “Enter” or click “Search”	Show message don’t have car park if the name or address is incorrect

Exceptions:
- N/A

Business Rules:
- N/A

3. Software System Attribute

3.1. Usability

- User controls all system components via only mobile application.
- The system can install easily.
- User can learn how to use the system fast.

3.2. Reliability

3.3. Availability

- The mechanical component require electrical system to work well.
- Hardware components are easy to find in the market.

3.4. Security

- Mobile application require authentication and authorization implement well because manager and end user use the same application.

3.5. Maintainability

- Use plug and play component so we can easily replace it.

3.6. Portability

- Easy to construct.

3.7. Performance

- Detection car is fast, less then 50ms.
- The speed of server can scale base on the budget easily.

4. Conceptual Diagram

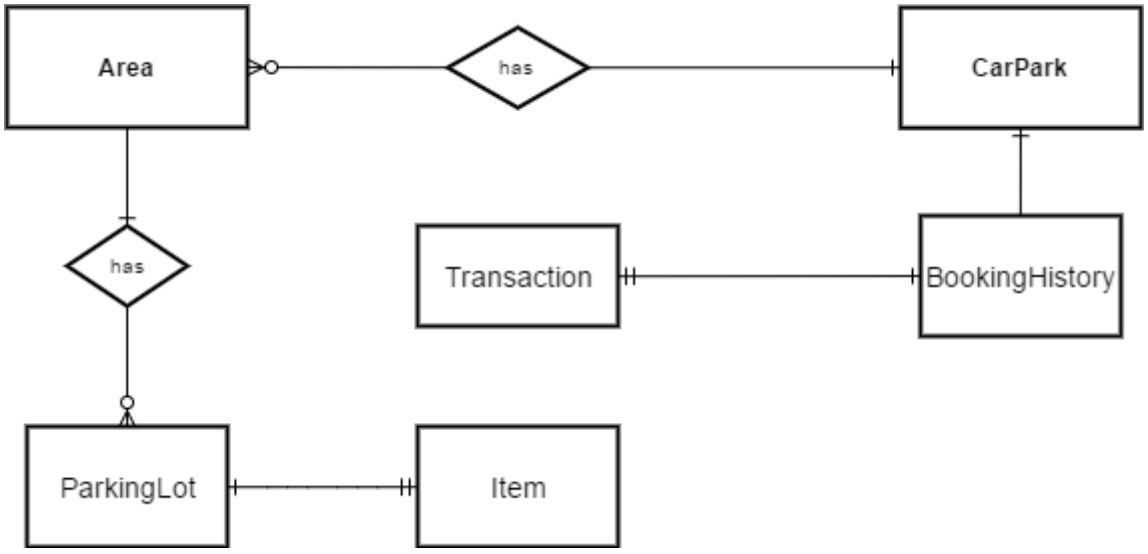

Figure 135: Conceptual Diagram

Data Dictionary

Entity Data dictionary: describe content of all entities	
Entity Name	**Description**
CarPark	Descript all car park information in the system
Area	Describe all area detail in car park
ParkingLot	Describe parking lot information in the area
Item	Describe hardware item in each parking lot
BookingHistory	Describe the booking history of the user
Transaction	Save the transaction of each booking