SMART GARAGE SYSTEM

CSE457: Mobile and Wireless Networks

PREPARED FOR

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ABSTRACT

This report presents a comprehensive study of a state-of-the-art smart parking system. The system, simulated using Cisco Packet Tracer, offers a unique blend of technology and convenience, providing real-time information about available parking slots. A tangible hardware prototype further validates the system's practicality. Notably, the system incorporates a fire detection module, enhancing safety measures. Additionally, it features a user-friendly mobile application, enabling clients to interact with the system effortlessly. This innovative approach transforms the parking experience, making it efficient, safe, and user centric.

INTRODUCTION

In the era of rapid technological advancement, the concept of smart cities is gaining momentum, and a crucial component of this vision is the development of smart parking systems. This report delves into the design and implementation of an innovative smart parking system that aims to revolutionize the traditional parking experience.

The system, simulated in Cisco Packet Tracer and validated through a hardware prototype, offers real-time visibility of available parking slots, a car washing service, and a comfortable lounge for clients. It also incorporates a fire detection module and surveillance, ensuring safety alongside convenience. Furthermore, the system is equipped with a user-friendly mobile application, allowing clients to send and receive commands seamlessly.

This report provides a comprehensive overview of the system's design, features, and benefits, demonstrating how technology can transform mundane tasks like parking into efficient and enjoyable experiences. The insights and findings presented in this report could serve as a valuable reference for future research and development in the field of smart parking systems. Stay tuned as we navigate through the intricacies of this state-of-the-art system, its simulation, prototyping, and real-world implications.

BACKGROUND

The concept of smart parking systems has emerged as a significant advancement in the field of urban development. With the increasing number of vehicles and the consequent demand for parking spaces, efficient management of parking facilities has become a pressing concern. Traditional parking systems often lead to congestion, inefficient use of space, and increased carbon emissions due to vehicles idling while searching for parking.

In response to these challenges, smart parking systems have been developed. These systems leverage technology to optimize parking space utilization, reduce congestion, and enhance the user experience. They employ various technologies such as Internet of Things (IoT), sensor technology, and mobile applications to provide real-time information about available parking slots, thereby reducing the time spent searching for parking.

This report focuses on a unique smart parking system that goes beyond just providing information about available slots. It incorporates additional features like a car washing slot, a smart lounge for clients to rest, a fire detection element for enhanced safety, and a mobile app for easy interaction with the system. This system represents a significant step forward in the evolution of smart parking solutions, offering a comprehensive and user-centric approach to parking management.

The following sections will provide a detailed overview of this innovative system, its design, implementation, and the benefits it offers to users and the environment.

OBJECTIVE

Our mission is to revolutionize the parking experience by integrating technology, convenience, and comfort. We aim to provide a seamless and efficient parking solution that not only optimizes space utilization but also offers value-added services like car washing and a smart lounge. Our commitment is to ensure customer satisfaction by offering a stress-free parking experience and enhancing the quality of time spent during their wait.

Our vision is to be the leading smart parking solution provider, known for our innovative approach and customer-centric services. We envision a future where parking is no longer a mundane task but a sophisticated, enjoyable experience. By continuously evolving and adapting to technological advancements, we strive to transform parking lots into smart hubs that cater to all

customer needs while they wait for their cars. We see ourselves setting new standards in the industry, making parking efficient, smart, and enjoyable.

SCOPE

This project focuses on the design and implementation of a smart parking system. The system provides real-time parking slot information, a car washing service, a smart lounge, and a fire detection module. It's controlled via a mobile app for easy user interaction. The system is simulated using Cisco Packet Tracer and validated with a hardware prototype. The project does not involve the use of AI-based models. Future enhancements could include AI integration, but they are outside the current project scope.

SYSTEM DESIGN

The design of our smart parking system prioritizes safety, efficiency, and comfort. The integrated fire detection module enhances safety measures, providing an immediate response in case of fire incidents. Surveillance features ensure security within the premises. The system's real-time parking slot information saves valuable time for users. Additionally, the smart lounge offers a comfortable waiting area, enhancing the overall user experience. All these components communicate together to offer our customers the experience they desire.

Components & Functionality

1. Microcontrollers: microcontrollers (MCU-PT) are used to connect and control IoT components. They can be programmed using Python to read inputs from sensors and control actuators. We used 5 microcontrollers in our simulation because each microcontroller has only 10 pins of digital and analog connections. The microcontroller is used to control the components that are connected to it.
   For example, we have 4 microcontrollers, and each microcontroller is connected to 5 sensors and 5 Leds. What we want to do is that when a car enters the parking slot, the sensor senses that there is a car that has occupied this parking slot, and the microcontroller switches the LEDs on once the slot is occupied.

```
from udp import *
from gpio import *
from time import *

def onUDPReceive(ip, port, data):
    print("received from "
        + ip + ":" + str(port) + ":" + data);

def init_pins():
    pinMode(0, INPUT)
    pinMode(2, INPUT)
    pinMode(4, INPUT)
    pinMode(6, INPUT)
    pinMode(8, INPUT)
    pinMode(1, OUTPUT)
    pinMode(3, OUTPUT)
    pinMode(5, OUTPUT)
    pinMode(7, OUTPUT)
    pinMode(9, OUTPUT)

def sense():
    result = [0, 0, 0, 0, 0]
    for i in range(5):
        pin = i*2
        status = digitalRead(pin)
        result[i] = status
    return result

def actuate(status):
    for i in range(5):
        pin = i*2 + 1
        digitalWrite(pin, status[i])
```

```
def main():
    socket = UDPSocket()
    socket.onReceive(onUDPReceive)
    print(socket.begin(1235))

    # count = 0
    # while True:
    #   count += 1
    #   data = "hello " + str(count)
    #   for i in range(1, 254):
    #       socket.send("1.1.1."+str(i), 1235, data)
    #   sleep(5)

    init_pins()

    while True:
        result = sense()
        actuate(result)
        socket.send("1.1.1.2", 1235, " ".join(map(str, result)))
        sleep(1)

if __name__ == "__main__":
    main()
```

2. Trip wire Sensors: This sensor is used to detect the presence of the car. These sensors can be connected to a microcontroller and programmed to trigger certain actions. We have trip wire sensors to sense whether a car has occupied the parking slot or not.

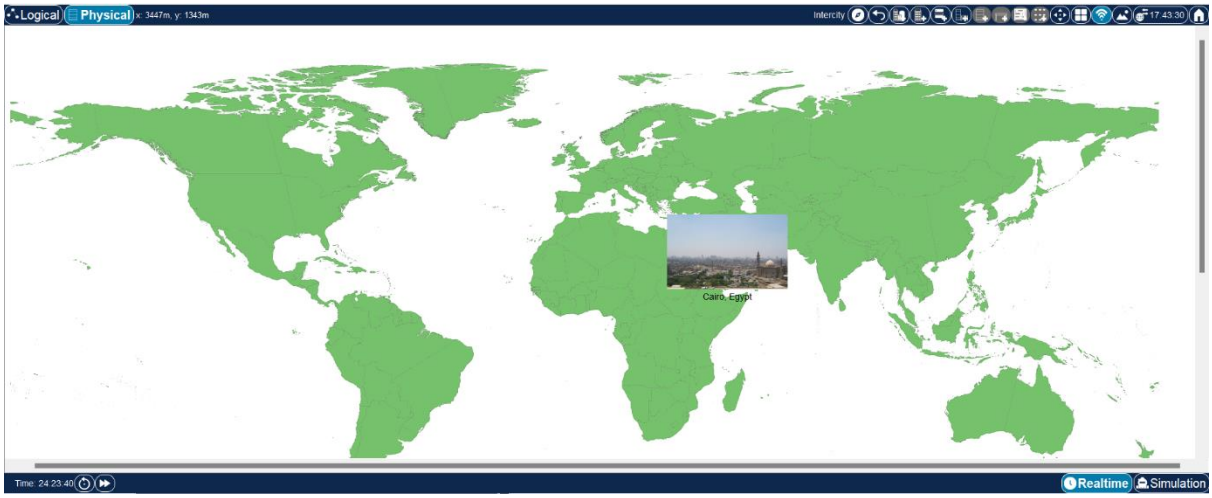
```
from udp import *
from time import *
from gpio import *
import json

def onUDPReceive(ip, port, data):
    state = json.loads(data)
    print("recieved " + data)
    count = 0
    for key, value in state.items():
        for val in value:
            if val == "0":
                count += 1
    print(count)
    if count == 0:
        customWrite(1, HIGH)
    else:
        customWrite(1, HIGH)
    customWrite(0, str(count) + " free slots.")

def main():
    socket = UDPSocket()
    socket.onReceive(onUDPReceive)
    print(socket.begin(1235))

    count = 20
    while True:
        sleep(5)

if __name__ == "__main__":
    main()
```

3. LEDs: LEDs can be used as indicators. They can be controlled by a microcontroller and programmed to turn on or off based on certain conditions. These LEDs will be switched on once a car occupies a specific parking slot.
4. LCD: The LCD here is used to count the number of slots that are empty and is connected to a microcontroller which has the code that controls the LCD and counts the number of empty slots that will be displayed on the LCD.
5. Laptop: Acts as a server for receiving the requests of the user and sending back the responses.
6. Mobile Phone: Represents the smart phone of the user which will display where the user should go for an empty slot.
7. Home Gateway: The Home Gateway in Packet Tracer provides network connectivity for IoT devices. It can connect to the internet and allow remote management of connected devices.
8. Entrance door: from which the user can enter the park and occupy a parking slot.
9. Webcam: A webcam in Packet Tracer can be used as a security device. It can be connected to a network and programmed to capture and transmit video data.
10. Siren: A siren in Packet Tracer can be used as an alarm device. It can be connected to a microcontroller and programmed to sound based on certain conditions.
11. Smoke Detector: A smoke detector in Packet Tracer can be used to detect smoke. It can be connected to a microcontroller and programmed to trigger an alarm when smoke is detected.
12. Server: A server in Packet Tracer can be used to provide services to other devices on the network, such as web services, email services, DNS services, and more.
13. RFID Reader: An RFID reader in Packet Tracer can be used to read data from RFID tags. It can be connected to a microcontroller and programmed to perform actions based on the data read from the tags which is opening the door and turning on all appliances in the lounge room.
14. Door: A door in Packet Tracer can be used as a controllable barrier. It can be connected to a microcontroller and programmed to open or close based on certain conditions. These devices include a door, air conditioner, lamp, and a coffee machine.

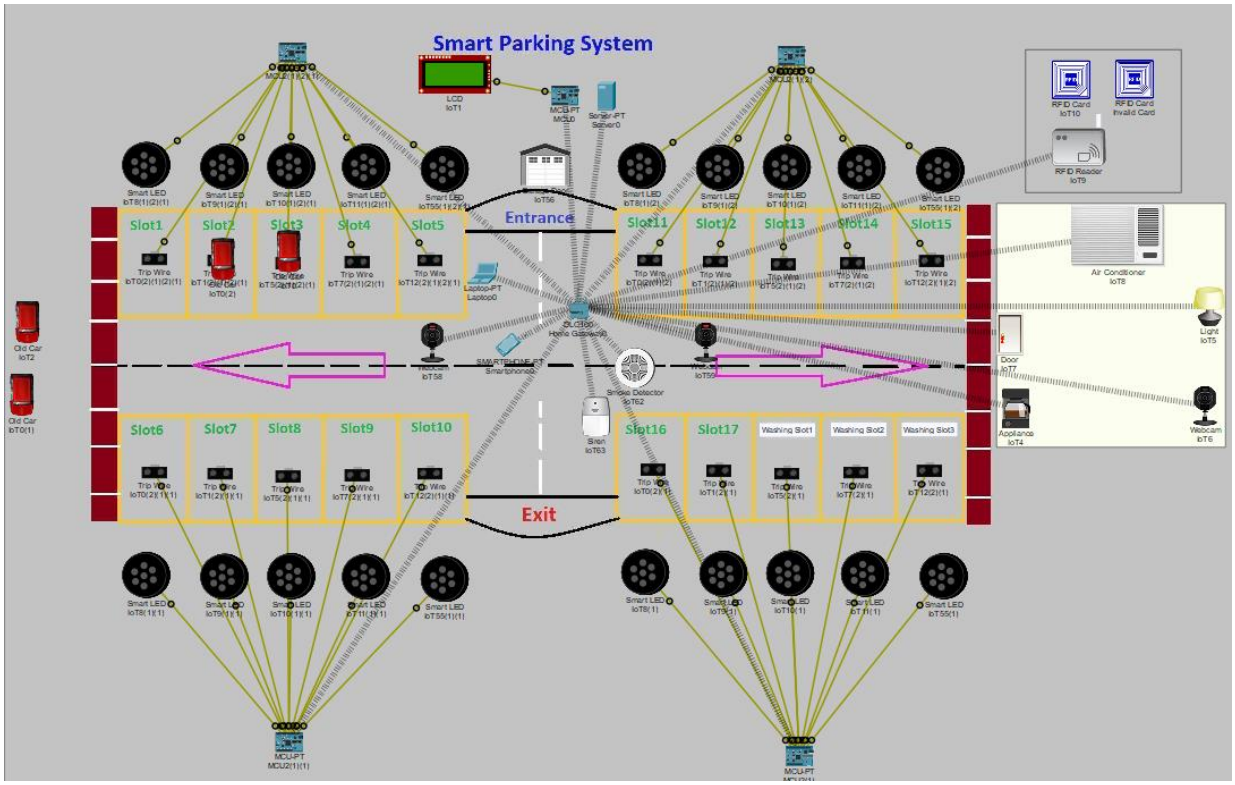
SIMULATION

In this section, we’re aiming to demonstrate our system and how packets and routed within it using cisco packet tracer. Through this section we were able to realize the usage and benefits of wireless networks.

Physical View



Logical View



HARDWARE PROTOTYPE

Main Components Used

1. Servo motor: To simulate the door opening and closing.
2. LEDs: indicate if a slot is taken.
3. LCD: display the amount of available slots.
4. Bluetooth module: send and receive commands.
5. Infrared sensors: sense if a car is near the door.
6. Smoke sensor: detect if a fire has started.

Future Work

These enhancements would not only improve the client experience but also increase the efficiency and profitability of the smart garage system:

1. **Automated Car Washing**: Implementing a fully automated car washing system that can detect the size and model of the car and adjust the washing mechanism accordingly. This system could also include different washing modes for different levels of dirt and grime.

2. **Smart Lounge**: The lounge could be equipped with smart furniture that adjusts to the comfort preferences of the client. This could include temperature-controlled seating, adjustable lighting, and noise-cancelling technology. The lounge could also offer entertainment options like a smart TV or VR headset for clients to use while they wait.

3. **Real-Time Updates**: The system could provide real-time updates to clients about the status of their car wash through a mobile app or digital display in the lounge. This would allow clients to know exactly when their car will be ready.

4. **Energy Efficiency**: The system could incorporate energy-efficient technologies, such as solar panels or water recycling systems, to reduce its environmental impact.

5. **Personalized Experience**: The system could remember the preferences of repeat clients and automatically adjust the car wash settings and lounge environment to their liking.

6. **Expansion of Services**: Additional services could be offered, such as detailing, tire rotation, or oil changes, turning the smart garage into a one-stop shop for car maintenance.

7. **Partnerships**: The smart garage could partner with local businesses to offer clients discounts or special offers while they wait for their car to be washed. This could include local restaurants, coffee shops, or retail stores.

QUESTIONS AND ANSWERS

1. **What is the main advantage of using a Home Gateway in an IoT system?**

    a) It increases the range of Bluetooth devices.
    b) It allows IoT devices to connect to the internet through wireless or wired interfaces.
    c) It reduces the power consumption of IoT devices.
    d) It increases the storage capacity of IoT devices.

2. **Which of the following is not a typical application of RFID technology?**

a) Inventory management
b) Access control
c) Environmental monitoring
d) Video streaming

Which wireless technology is commonly used for short-range communication in smart parking systems?

a) Wi-Fi
b) Bluetooth
c) Zigbee
d) LoRaWAN

3. **What is the main challenge in implementing a server in an IoT system?**

a) Ensuring real-time communication
b) Managing power consumption
c) Ensuring data security
d) Managing storage capacity

4. **What is the main challenge in implementing RFID technology in an IoT system?**

a) Ensuring real-time communication
b) Managing power consumption
c) Ensuring data security
d) Managing storage capacity

5. **What is the main advantage of using a dual-band Wi-Fi router?**

a) It can connect to more devices at once.
b) It can operate on both the 2.4 GHz and 5 GHz bands, reducing interference and improving performance.
c) It can transmit data at twice the speed of a single-band router.
d) It can cover a larger area than a single-band router

6. **What is MIMO technology in the context of Wi-Fi?**

a) A technology that allows a Wi-Fi router to communicate with multiple devices simultaneously.
b) A technology that increases the range of a Wi-Fi network.
c) A technology that improves the security of a Wi-Fi network.
d) A technology that reduces the power consumption of a Wi-Fi router.

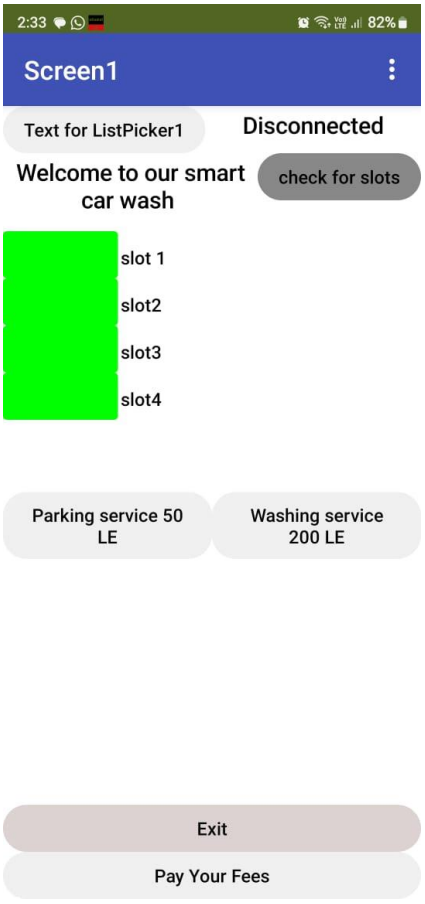
7. **What is the purpose of Wi-Fi Protected Access (WPA) in a Wi-Fi network?**

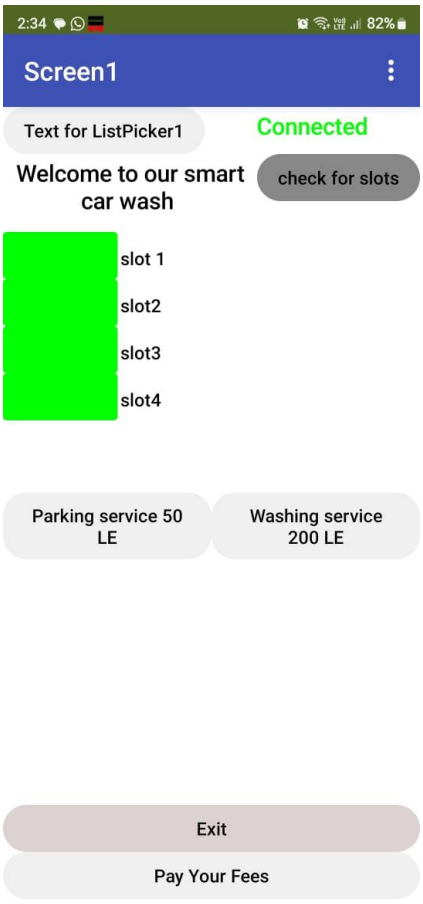
a) To increase the range of the Wi-Fi signal.
b) To improve the speed of data transmission.
c) To protect the network from unauthorized access.
d) To reduce the power consumption of the Wi-Fi router.

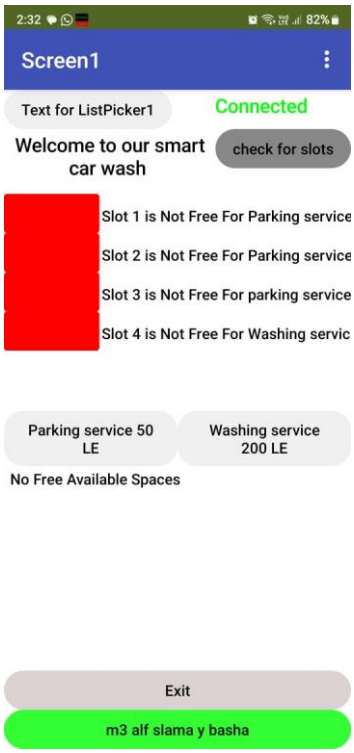
8. **In the context of IoT, why is the MQTT protocol often preferred over HTTP for data transmission?**

a) MQTT supports video streaming, while HTTP does not.
b) MQTT uses a smaller data payload, making it more efficient for IoT devices.
c) HTTP is not capable of real-time data transmission.
d) MQTT is newer and more modern than HTTP.

MOBILE APPLICATION







1. check for slots button: it sends to the controller wireless to retrieve the status of the slots.
2. Parking service: it is used to book a slot or parking if available it opens the door , and show the direction for this slot in the text area
3. Washing service: it is used to book a slot of washing the car.
4. Exit : is used to calculate the fees and shows it up in the button
5. Pay your fees: is clicked to pay your fees and open the door to leave the garage

CONCLUSION

In conclusion, the aim of this project was successfully achieved. We were able to utilize wireless connections and gain a deeper understanding of networks through the practical application of building an Internet of Things (IoT) system. This system, which we have termed as the Smart Garage system, has demonstrated the potential and versatility of IoT in real-world scenarios.

The system integrates various components such as microcontrollers, sensors, LEDs, LCDs, a laptop server, a mobile phone user interface, a home gateway, and more. Each component plays a crucial role in the functionality of the system, from detecting the presence of a car in a parking slot to controlling the LEDs and displaying the number of empty slots on an LCD.

Furthermore, the system enhances the user experience by offering automated car washing services and a smart lounge for clients to wait in. The inclusion of cameras and an alarm system ensures security, while the integrated payment service provides convenience for the users.

Overall, this project not only served as a valuable learning experience in wireless networking and IoT systems but also resulted in a functional and efficient smart garage system that could potentially revolutionize the way we think about car parking and maintenance services. The future enhancements planned for this system, such as energy-efficient technologies and personalized experiences, promise to make it even more beneficial and user-friendly.