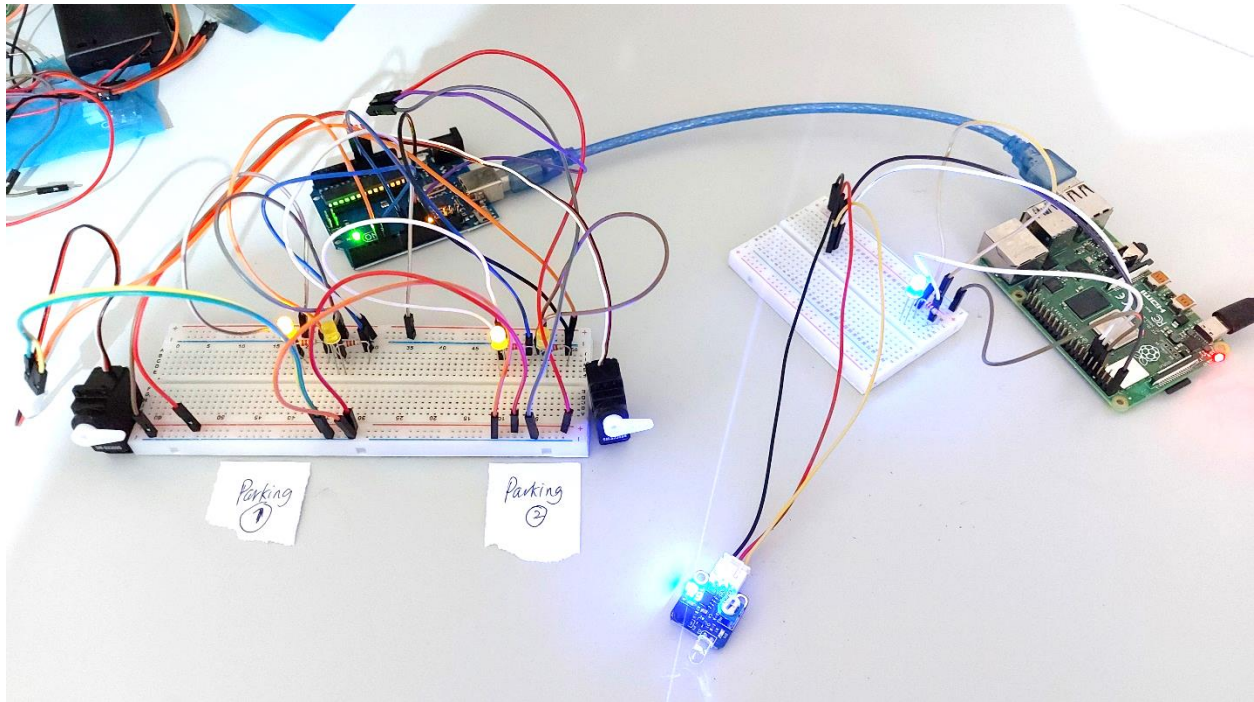


Smart Parking using Raspberry Pi 4 and Arduino

Internet of Things, Web & Mobile



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1. Create a daemon that launches the program when you start the Raspberry Pi 4.

1.1. Create the Raspberry Pi 4 Python program which will start on boot

After creating the Python program **Smart Parking** which is in the **/home/pi/hraspberry** as the home repository. The program filename is "*SmartParking.py*"

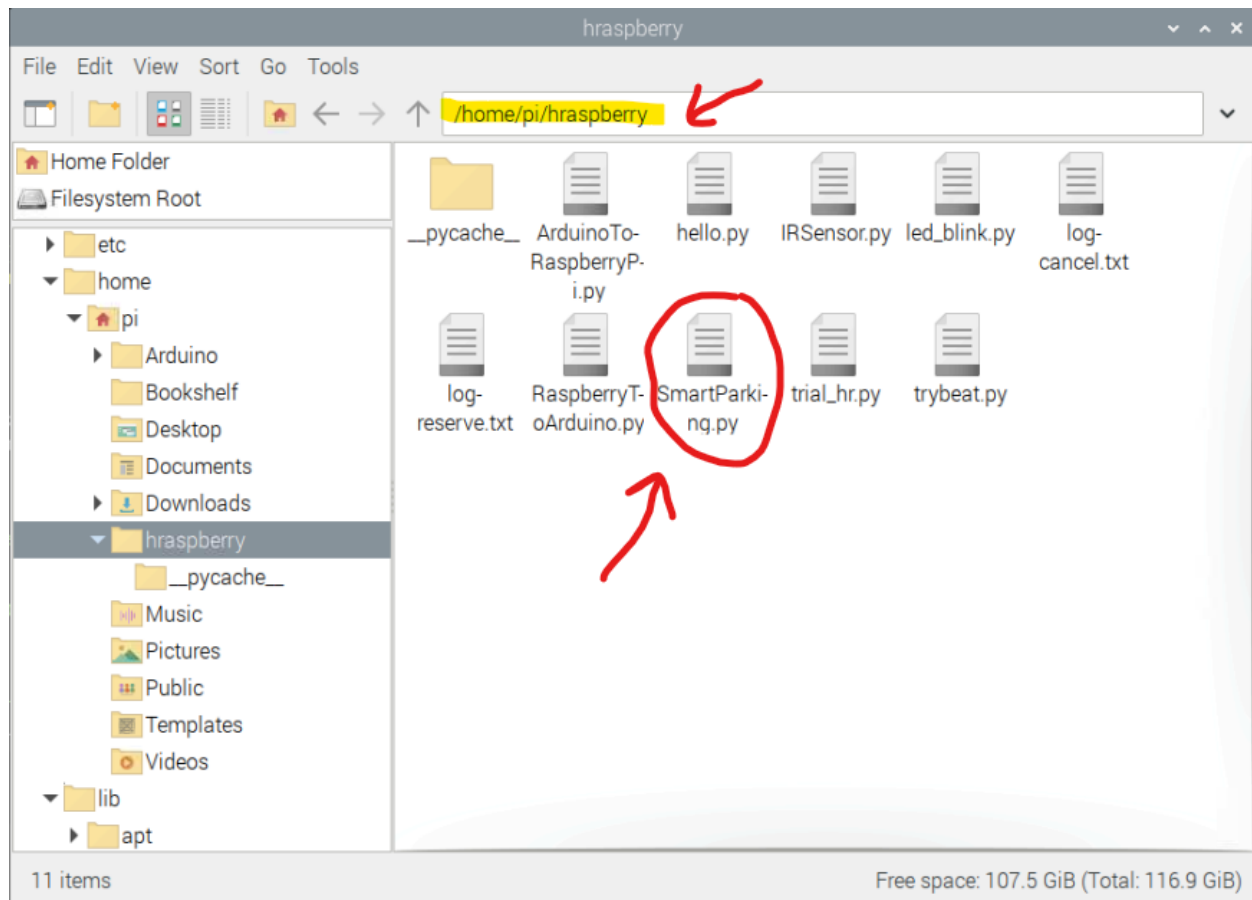


Fig 1. Home repository with python program

1.2. Add a systemd service

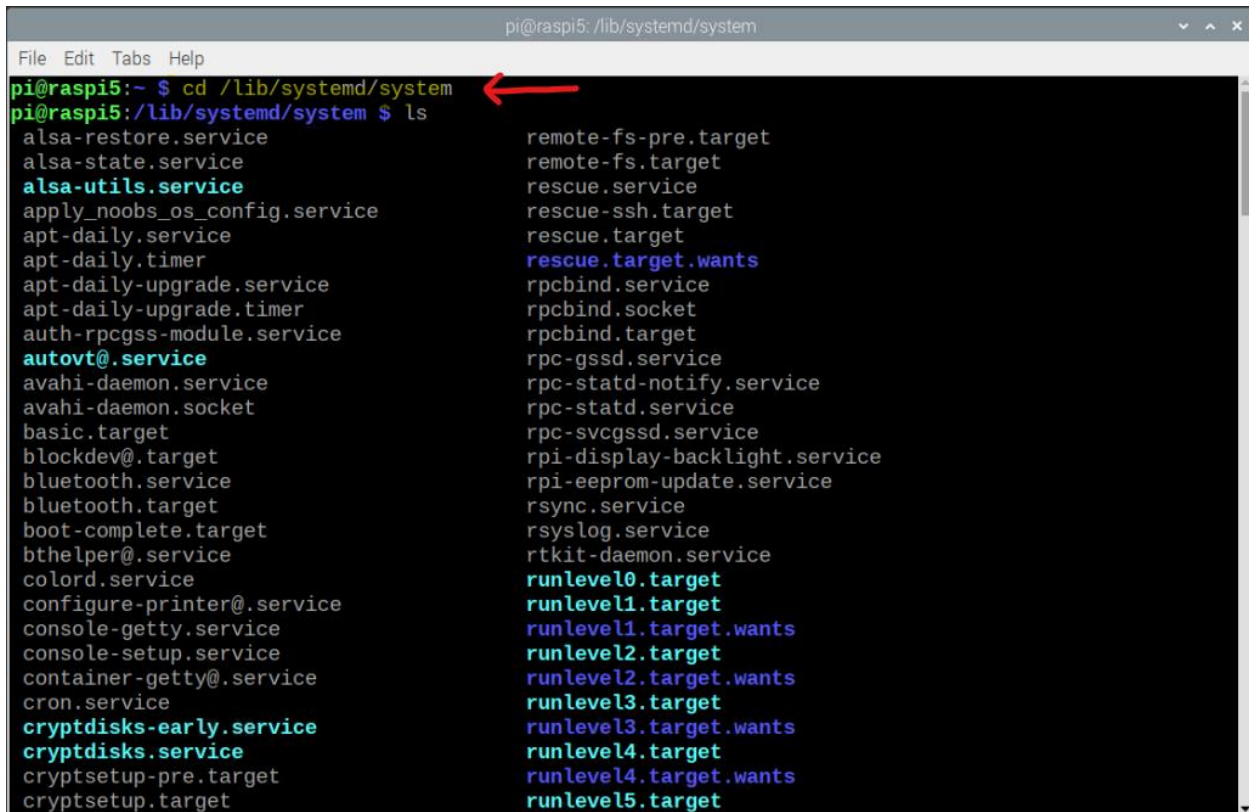
Now that we have a Python program script, and we know it's working correctly, let's create a new **systemd service**.

Step to follow:

1. Open the **Terminal**

2. Go to “`/lib/systemd/system`”. All services will be in the “`/lib/systemd/system`” folder. On boot, **systemd** will look after all enabled services and start them.

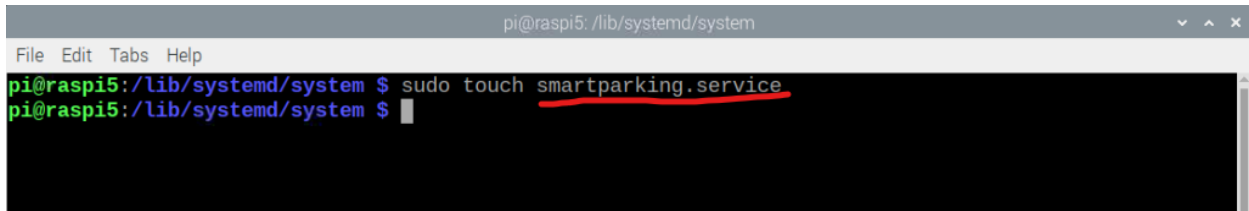
```
| cd /lib/systemd/system
```



```
pi@raspi5: /lib/systemd/system
File Edit Tabs Help
pi@raspi5:~ $ cd /lib/systemd/system
pi@raspi5:/lib/systemd/system $ ls
alsa-restore.service      remote-fs-pre.target
alsa-state.service        remote-fs.target
alsa-utils.service        rescue.service
apply_noobs_os_config.service rescue-ssh.target
apt-daily.service         rescue.target
apt-daily.timer           rescue.target.wants
apt-daily-upgrade.service rpcbind.service
apt-daily-upgrade.timer  rpcbind.socket
auth-rpcgss-module.service rpcbind.target
autovt@.service          rpc-gssd.service
avahi-daemon.service     rpc-statd-notify.service
avahi-daemon.socket      rpc-statd.service
basic.target             rpc-svcgssd.service
blockdev@.target         rpi-display-backlight.service
bluetooth.service       rpi-eeprom-update.service
bluetooth.target        rsync.service
boot-complete.target     rsyslog.service
bthelper@.service        rtkit-daemon.service
colord.service           runlevel0.target
configure-printer@.service runlevel1.target
console-getty.service    runlevel1.target.wants
console-setup.service    runlevel2.target
container-getty@.service runlevel2.target.wants
cron.service            runlevel3.target
cryptdisks-early.service runlevel3.target.wants
cryptdisks.service       runlevel4.target
cryptsetup-pre.target    runlevel4.target.wants
cryptsetup.target        runlevel5.target
```

3. Create the new system service namely “**smartparking.service**”.

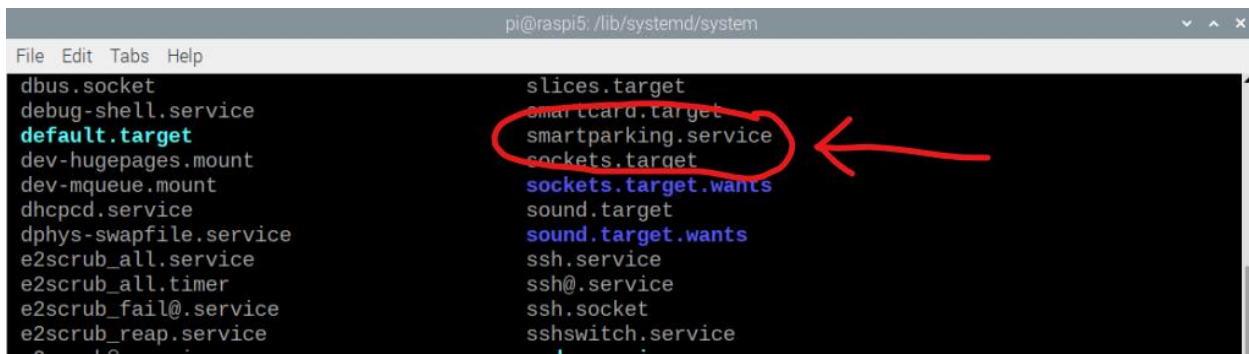
```
sudo touch smartparking.service
```



```
pi@raspi5: /lib/systemd/system
File Edit Tabs Help
pi@raspi5:/lib/systemd/system $ sudo touch smartparking.service
pi@raspi5:/lib/systemd/system $
```

4. Verify if service “**smartparking.service**” created successfully. Type **ls** to the Terminal

```
ls
```



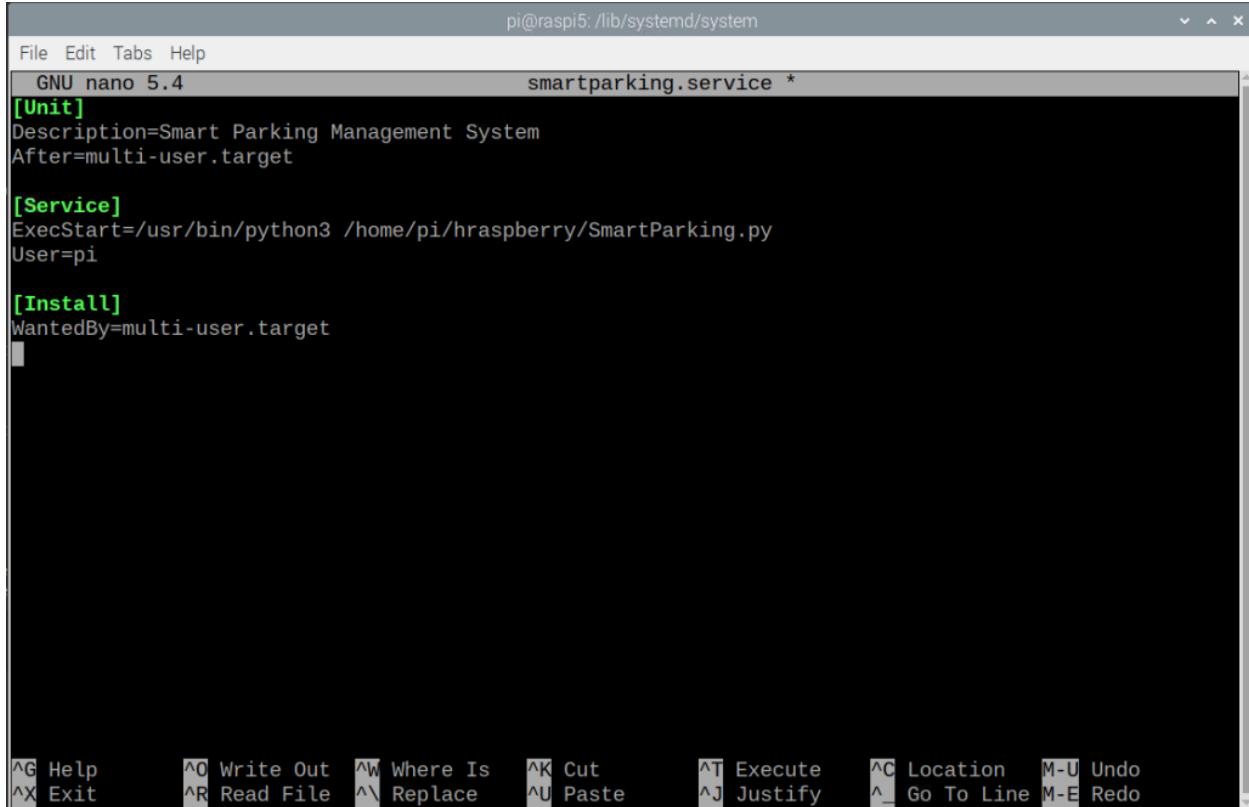
```
pi@raspi5: /lib/systemd/system
File Edit Tabs Help
dbus.socket
debug-shell.service
default.target
dev-hugepages.mount
dev-mqueue.mount
dhcpcd.service
dphys-swapfile.service
e2scrub_all.service
e2scrub_all.timer
e2scrub_fail@.service
e2scrub_reap.service
slices.target
smartcard.target
smartparking.service
sockets.target
sockets.target.wants
sound.target
sound.target.wants
ssh.service
ssh@.service
ssh.socket
sshswitch.service
```

5. Now, edit this file (with **sudo nano smartparking.service**) and write the following:

```
[Unit]
Description=Smart Parking Management System
After=multi-user.target

[Service]
ExecStart=/usr/bin/python3 /home/pi/hraspberry/SmartParking.py
User=pi

[Install]
WantedBy=multi-user.target
```



```

pi@raspi5: /lib/systemd/system
File Edit Tabs Help
GNU nano 5.4 smartparking.service *
[Unit]
Description=Smart Parking Management System
After=multi-user.target

[Service]
ExecStart=/usr/bin/python3 /home/pi/hraspberry/SmartParking.py
User=pi

[Install]
WantedBy=multi-user.target
  
```

Fig 2. Systemd service script

Important:

This is a very basic template for writing a **systemd** service. Here's what each field means:

- **Description:** not important, just write anything you want here about the project.
- **After:** this controls when the service should be triggered. Basically, "*multi-user.target*" means that the service will be triggered once the multi-user environment is available. Note that this will not wait until the login or desktop screen appears.
- **ExecStart:** the actual command line to execute. Here we start the Python script that we've created in the home repository. Note that it's important to use an absolute path for the script path.
- **User:** if we don't specify the user, then the program will be executed as root user. What could be the problem here? Well, the Python script we execute is creating a file. If the root user launches the Python script, then the file will be created by the root user, not by the "*pi*" user. So, the "*pi*" user might encounter permission issues when trying to modify/remove this script.
- **WantedBy:** as we specified "*multi-user.target*" before, we need to also write it here.

1.3. Enable the systemd service

Need to enable the service so systemd will run it on boot.

Step to follow:

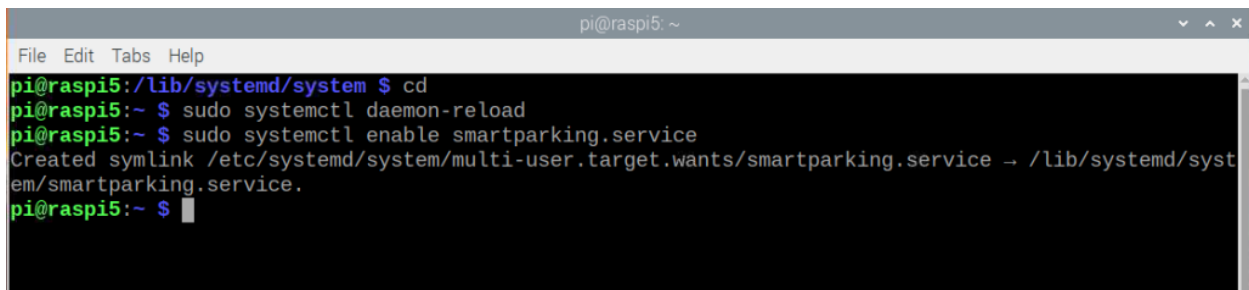
1. We need to tell systemd to recognize our service, so enter:

```
sudo systemctl daemon-reload
```

* Note that you will need to enter this command every time you change your **.service** file, as **systemd** needs to know it has been updated.

2. Tell systemd that the service needs to start on boot.

```
sudo systemctl enable smartparking.service
```



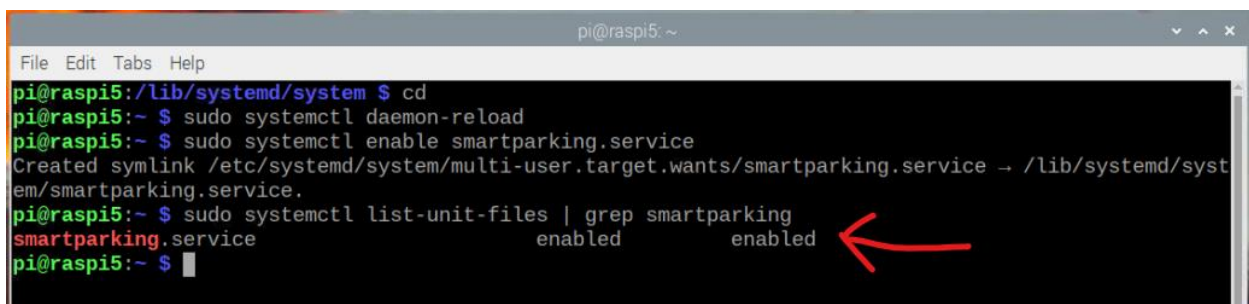
```
pi@raspi5: ~  
File Edit Tabs Help  
pi@raspi5:/lib/systemd/system $ cd  
pi@raspi5:~ $ sudo systemctl daemon-reload  
pi@raspi5:~ $ sudo systemctl enable smartparking.service  
Created symlink /etc/systemd/system/multi-user.target.wants/smartparking.service → /lib/systemd/system/smartparking.service.  
pi@raspi5:~ $
```

* Reboot with **sudo reboot** to verify that the program works. The LED should begin to turn ON after the Pi boots!

3. To check if the service is enabled, use this command:

```
sudo systemctl list-unit-files | grep smartparking
```

* This tells that 1. The “smartparking” service exists, and 2. it is enabled.



```
pi@raspi5: ~  
File Edit Tabs Help  
pi@raspi5:/lib/systemd/system $ cd  
pi@raspi5:~ $ sudo systemctl daemon-reload  
pi@raspi5:~ $ sudo systemctl enable smartparking.service  
Created symlink /etc/systemd/system/multi-user.target.wants/smartparking.service → /lib/systemd/system/smartparking.service.  
pi@raspi5:~ $ sudo systemctl list-unit-files | grep smartparking  
smartparking.service          enabled          enabled  
pi@raspi5:~ $
```


1.4. Disable the systemd service

1. Need to disable the service, simply do:

```
| sudo systemctl disable smartparking.service
```

2. Code Explanation

2.1. Python code "SmartParking.py"

```
"""
Assignment Title: Gestion de parking intelligent
Purpose          : Implementation of Smart Parking
Language         : Python
Author           : Hemant Ramphul
Github           : https://github.com/hemantramphul/Smart-Parking/
Date             : 05 January 2023

Université des Mascareignes (UdM)
Faculty of Information and Communication Technology
Master Artificial Intelligence and Robotics
Official Website: https://udm.ac.mu
"""

import RPi.GPIO as GPIO # Importing the library of RPi.GPIO
import time # Importing the library of time
import serial # Importing the library of time
import string # Importing the library string
import random # Importing the library random
import os # Importing the library os
from datetime import datetime # Importing the library datetime

# Format to store date
fmt = '%Y-%m-%d %H:%M:%S'

# Filename
fileLogReserve = "log-reserve.txt" # Log all reserved parking info
fileLogCancel = "log-cancel.txt" # Log all cancellation parking info

# [True] -> Reservation mode
# [False] -> Unlock mode
modeUnlockOrReserve = True

# Parking
parkingOneAvailable = True
parkingTwoAvailable = True

led = 17 # Declaring GPIO 17 of Raspberry Pi
sensor = 27 # Declaring GPIO 27 of Raspberry Pi

GPIO.setmode(GPIO.BCM) # Declaring the BCM mode of pins
GPIO.setwarnings(False) # Disabled warning
GPIO.setup(sensor, GPIO.IN) # Set the behaviour of sensor as input
GPIO.setup(led, GPIO.OUT) # Set the behaviour of led as output
```




```
def secretCode(length=4):
    """
    Function to generate a secret code
    :param length: 4 is the default number
    :return: String [secret code]
    """
    # Choose from all digits 0123456798
    letters = string.digits
    # Generate secret code
    code = ''.join(random.choice(letters) for i in range(length))

    return code # Generated secret code

def sensorCheck():
    """
    Function to check if a car is near sensor
    :return: boolean [True or False]
    """
    try:
        while GPIO.input(sensor): # Checking input on sensor
            GPIO.output(led, False) # Led turned on
            while GPIO.input(sensor): # Checking input on sensor again
                time.sleep(0.2) # Time delay of 0.2 seconds
            GPIO.output(led, True) # Led turned off if there is no input on
sensor
    except KeyboardInterrupt: # If any key is pressed on keyboard terminate
the program
        GPIO.cleanup() # Cleanup the GPIO pins for any other program use

    return GPIO.input(sensor)

def splitLog(line):
    """
    Function to split line contains ";"
    :param line:
    :return: array
    """
    return line.split(';')

def CheckParkingExpiredTime(reserved_time):
    """
    Function to check expired date with 15 seconds
    :param reserved_time:
    :return: boolean [True or False]
    """
    # Check expiration time
    t = datetime.now()
    expired = datetime.strptime(t, fmt) - datetime.strptime(reserved_time,
fmt)
    # Returns the difference of the time
    minutes = divmod(expired.seconds, 60)

    # Check if time have pass 15 seconds
```



```
        return True if minutes[1] > 15 else False

def readResponse():
    """
    Function to read Arduino response
    :return:
    """
    while arduino.inWaiting() == 0: pass # Wait for Arduino to answer if any
    if arduino.inWaiting() > 0:
        answer = arduino.readline() # Read answer
        print("{}".format(answer)) # Display answer

def writeToFile(code, parking):
    """
    Function to write to a log file [Reserve]
    :param code: secret code
    :param parking: Parking number
    :return:
    """
    fileToWrite = open(fileLogReserve, "a") # Append mode
    # Save record like "code,parking_number,reserved,datetime"
    fileToWrite.write(code + ";" + parking + ";Reserved;" +
str(datetime.strftime(datetime.now(), fmt)) + "\n")
    fileToWrite.close() # Close file connection

def writeToFileCancel(line):
    """
    Function to write to a log file [Cancellation]
    :param line: log
    :return:
    """
    fileToWrite = open(fileLogCancel, "a") # Append mode
    slotInfo = splitLog(line) # Split line to takes some info
    fileToWrite.write(
        slotInfo[0] + ";" + slotInfo[1] + ";Canceled;" +
str(datetime.strftime(datetime.now(), fmt)) + "\n")
    fileToWrite.close() # Close file connection

def deleteLine(code):
    """
    Function to delete a line in log file
    :param code: secret code
    :return: boolean, String
    """
    log = ""
    deleted = False
    with open(fileLogReserve, "r") as input: # Read from file
        with open("temp.txt", "w") as output: # Use a temp file
            # Iterate all lines from file
            for line in input:
                if line.strip("\n").startswith(code):
                    log = line
                    writeToFileCancel(line)
```



```
        deleted = True
        # If line starts with substring 'code' then don't write it in
temp file
        if not line.strip("\n").startswith(code):
            output.write(line)

    # Replace file with original name
    os.replace('temp.txt', fileLogReserve)

    return deleted, log

def searchLog(code):
    """
    Function to search line in log file
    :param code: secret code
    :return: String
    """
    log = ""
    with open(fileLogReserve, "r") as input:
        for line in input:
            # If line contain Secret Code
            if line.strip("\n").startswith(code):
                log = line

    return log

# Main application start
if __name__ == '__main__':
    print('Smart Parking System. \nStatus [Running]. Press CTRL-C to
exit.\n') # App info
    GPIO.output(led, True) # Led turned on

    arduino = serial.Serial('/dev/ttyACM0', 9600, timeout=1) # Connect to
Arduino via specific port
    arduino.reset_input_buffer()

    time.sleep(0.1)
    if arduino.isOpen() and not sensorCheck():
        print("{} connected!".format(arduino.port)) # Check Arduino if is
well connected

        try:
            # Show message for mode option
            print(
                '[*] Type "R" to enter reservation mode. \n[*] Type "U" to
enter unlock mode. \n[*] Type "C" to enter '
                'cancelation mode.\n')

            while True:
                # User input according to option available
                userInput = input('Enter MODE "R" or "U" or "C": ')

                # Parking canceled
                if userInput.upper() == 'C':
                    # Enter secret code
```



```
        userCode = input('Enter Secret Code: ')
        deleted, log = deleteLine(userCode) # Call function
deleteLine to cancel reservation
        slotInfo = splitLog(log) # Split line to take some info
        if deleted:
            print(slotInfo[1], 'canceled.\n')
            if slotInfo[1] == 'Parking 1': # Check which car
Parking to cancel according to the secret code
                arduino.write(b'1P1') # Send Arduino information
to perform
                parkingOneAvailable = not parkingOneAvailable
            else:
                arduino.write(b'1P2') # Send Arduino information
to perform
                parkingTwoAvailable = not parkingTwoAvailable
            else: # If secret code not found
                print('Invalid secret code!\n')

# Parking Reservation
elif userInput.upper() == 'R':
    # Enter Parking number
    print('[*] Type "1" for Parking 1. \n[*] Type "2" for
Parking 2. \n')

    userParkingInput = input('Enter PARKING "1" or "2": ')
    code = secretCode() # Generate secret code
    available = False
    saveMsg = "Parking " + userParkingInput
    msg = ""

    if userParkingInput == "1" and parkingOneAvailable:
        parkingOneAvailable = not parkingOneAvailable
        available = True
        arduino.write(b'2P1') # Send Arduino information to
perform
        readResponse() # Read Arduino response
        writeToLog(code, saveMsg) # Write to log file
    elif userParkingInput == "2" and parkingTwoAvailable:
        parkingTwoAvailable = not parkingTwoAvailable
        available = True
        arduino.write(b'2P2') # Send Arduino information to
perform
        readResponse() # Read Arduino response
        writeToLog(code, saveMsg) # Write to log file
    elif not parkingOneAvailable and not parkingTwoAvailable:
        # Check if parking available or full
        msg = "Parking full!"
    else:
        # Check selected parking
        msg = "Selected parking is not available."

    print(msg)
    print("Secret Code: " + code if available else "")
    print('-----\n')

    modeUnlockOrReserve = True
# Parking Unlock
elif userInput.upper() == 'U':
```



```
# Enter secret code
userCode = input('Enter Secret Code: ')
log = searchLog(userCode) # Search information about the
Parking reserved with the secret code

if log != "":
    available = False
    # Get information in array
    slotInfo = splitLog(log)

    # Check expired date
    if CheckParkingExpiredTime(slotInfo[3].strip()):
        print('Secret Code expired!\n')
    else:
        if slotInfo[1] == 'Parking 1':
            arduino.write(b'3P1') # Send Arduino
information to perform
        else:
            arduino.write(b'3P2') # Send Arduino
information to perform

        readResponse()
        deleted, log = deleteLine(userCode) # Delete log in
log file

        modeUnlockOrReserve = False
    else:
        print('Invalid option!\n')
        print('-----\n')

except KeyboardInterrupt:
    print("KeyboardInterrupt has been caught.")
```

2.2. Arduino Code “SmartParking.ino”

```
#include <Servo.h>
// Connection from Raspberry Pi 4 to Arduino

Servo P1_SERVO; // Create servo object to control Parking 1 servo
Servo P2_SERVO; // Create servo object to control Parking 2 servo
int P1_LED1_PIN = 5; // Assign as YELLOW Led 1 (Parking 1)
int P1_LED2_PIN = 6; // Assign as YELLOW Led 2 (Parking 1)
int P2_LED1_PIN = 9; // Assign as YELLOW Led 1 (Parking 2)
int P2_LED2_PIN = 10; // Assign as YELLOW Led 2 (Parking 2)

int P1_SERVO_PIN = 11; // Assign servo (Parking 1)
int P2_SERVO_PIN = 12; // Assign servo (Parking 1)

String MSG; // Read Input
bool P1_AVAILABLE = true; // Disponibility of Parking 1
bool P2_AVAILABLE = true; // Disponibility of Parking 2
```



```
int pos = 0; // Variable to store the servo position

void setup() {
    // put your setup code here, to run once:
    Serial.begin(9600);
    pinMode(P1_LED1_PIN, OUTPUT);
    pinMode(P1_LED2_PIN, OUTPUT);
    pinMode(P2_LED1_PIN, OUTPUT);
    pinMode(P2_LED2_PIN, OUTPUT);
    P1_SERVO.attach(11); // Attaches the servo on pin 11 to the servo object
    P2_SERVO.attach(12); // Attaches the servo on pin 12 to the servo object

    P1_SERVO.write(map(0, 0, 1023, 0, 180)); // Status: Upper (default) - Parking 1
    P2_SERVO.write(map(0, 0, 1023, 0, 180)); // Status: Upper (default) - Parking 2

    delay(10);
    ParkingAvailable();
}

void loop() {
    // Read serial port
    ReadSerialPort();

    // Available: Parking 1 and Parking 2
    if (MSG == "1P1") { // Available: P1_LED1_PIN ON, P1_LED2_PIN OFF
        digitalWrite(P1_LED1_PIN, HIGH); // (Parking 1)
        digitalWrite(P1_LED2_PIN, LOW); // (Parking 1)
        P1_SERVO.write(map(0, 0, 1023, 0, 180)); // Status: Upper (default) - Parking
1
        Serial.println("Parking 1 available!");
    } else if (MSG == "1P2") { // Available: P2_LED1_PIN ON, P2_LED2_PIN OFF
        digitalWrite(P2_LED1_PIN, HIGH); // (Parking 2)
        digitalWrite(P2_LED2_PIN, LOW); // (Parking 2)
        P2_SERVO.write(map(0, 0, 1023, 0, 180)); // Status: Upper (default) - Parking
2
        Serial.println("Parking 2 available!");
    }

    // Reserved: Parking 1 and Parking 2
    if (MSG == "2P1") { // Reserved: P1_LED1_PIN ON, P1_LED2_PIN ON
        digitalWrite(P1_LED1_PIN, HIGH); // (Parking 1)
        digitalWrite(P1_LED2_PIN, HIGH); // (Parking 1)
        Serial.println("Parking 1 reserved!");
    } else if (MSG == "2P2") { // Reserved: P2_LED1_PIN ON, P2_LED2_PIN ON
```



```
digitalWrite(P2_LED1_PIN, HIGH); // (Parking 2)
digitalWrite(P2_LED2_PIN, HIGH); // (Parking 2)
Serial.println("Parking 2 reserved!");
}

// Reserved and Parked: Parking 1 and Parking 2
if (MSG == "3P1") { // Reserved and Parked: P1_LED1_PIN OFF, P1_LED2_PIN ON
digitalWrite(P1_LED1_PIN, LOW); // (Parking 1)
digitalWrite(P1_LED2_PIN, HIGH); // (Parking 1)
P1_SERVO.write(map(0, 0, 1023, 180, 180)); // Status: Lower/Close - Parking 1
Serial.println("Parking 1 reserved and parked!");
} else if (MSG == "3P2") { // Reserved and Parked: P1_LED1_PIN OFF, P1_LED2_PIN
ON
digitalWrite(P2_LED1_PIN, LOW); // (Parking 2)
digitalWrite(P2_LED2_PIN, HIGH); // (Parking 2)
P2_SERVO.write(map(0, 0, 1023, 180, 180)); // Status: Lower/Close (default) -
Parking 2
Serial.println("Parking 2 reserved and parked!");
}

// Not Reserved and Parked: Parking 1 and Parking 2
if (MSG == "4P1") { // Reserved and Parked: P1_LED1_PIN OFF, P1_LED2_PIN
ON/BLINK
digitalWrite(P1_LED1_PIN, LOW); // (Parking 1)
BlinkLedParking1(); // (Parking 1)
Serial.println("Parking 1 reserved and parked!");
} else if (MSG == "4P2") { // Reserved and Parked: P1_LED1_PIN OFF, P1_LED2_PIN
ON/BLINK
digitalWrite(P2_LED1_PIN, LOW); // (Parking 2)
BlinkLedParking2(); // (Parking 2)
Serial.println("Parking 2 reserved and parked!");
}

delay(100); // Wait
}

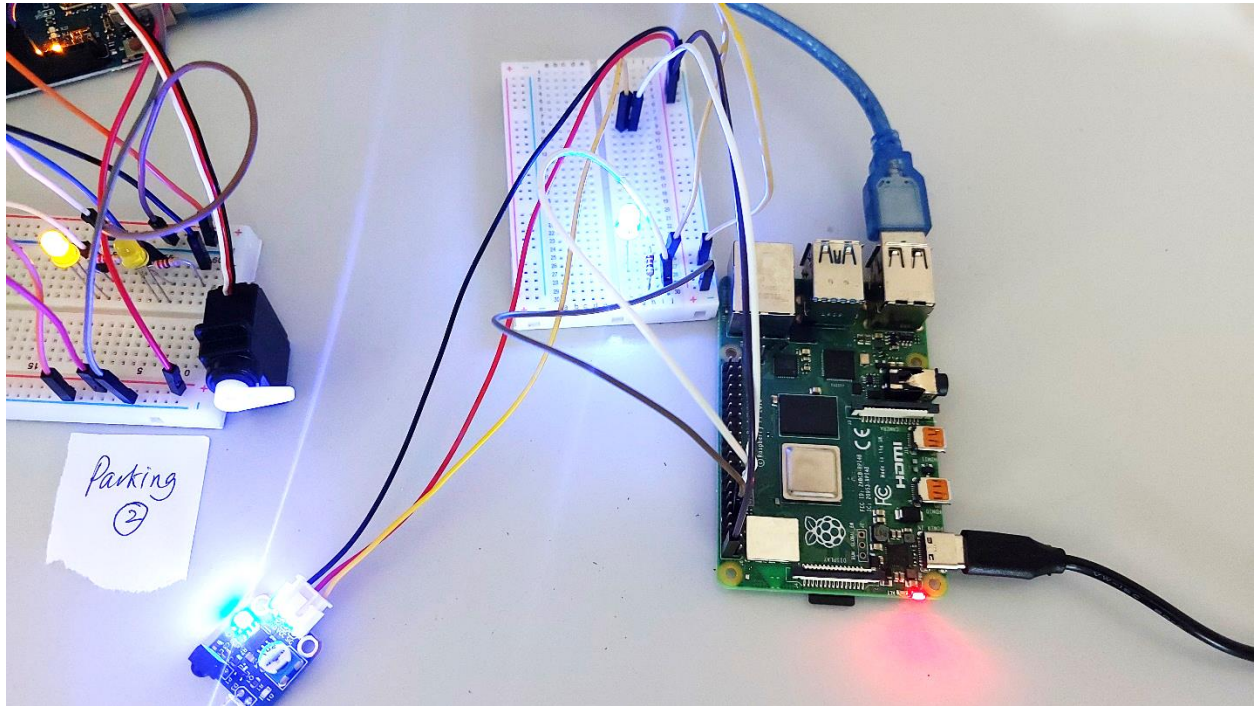
void ReadSerialPort() {
MSG = "";
// Check availability
if (Serial.available()) {
delay(10);
while (Serial.available() > 0) {
MSG += (char)Serial.read();
}
Serial.flush();
}
```



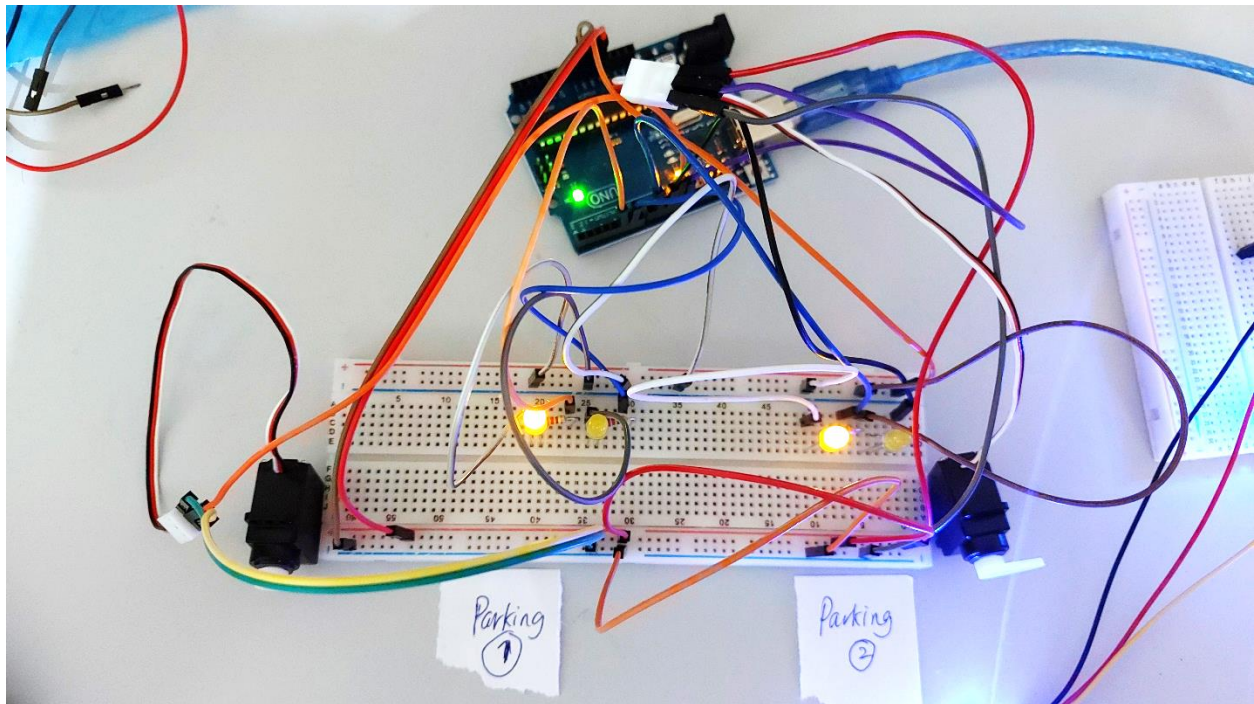
```
}  
}  
  
void ParkingAvailable() {  
    digitalWrite(P1_LED1_PIN, HIGH); // (Parking 1)  
    digitalWrite(P1_LED2_PIN, LOW); // (Parking 1)  
    digitalWrite(P2_LED1_PIN, HIGH); // (Parking 2)  
    digitalWrite(P2_LED2_PIN, LOW); // (Parking 2)  
}  
  
void BlinkLedParking1() {  
    while (Serial.available() < 2) {  
        //Serial.println(Serial.available());  
        digitalWrite(P1_LED2_PIN, HIGH); // (Parking 1)  
        delay(500);  
        digitalWrite(P1_LED2_PIN, LOW); // (Parking 1)  
        delay(500);  
    }  
}  
  
void BlinkLedParking2() {  
    while (Serial.available() < 2) {  
        //Serial.println(Serial.available());  
        digitalWrite(P2_LED2_PIN, HIGH); // (Parking 2)  
        delay(500);  
        digitalWrite(P2_LED2_PIN, LOW); // (Parking 2)  
        delay(500);  
    }  
}
```

3. Setup Raspberry Pi 4 and Arduino

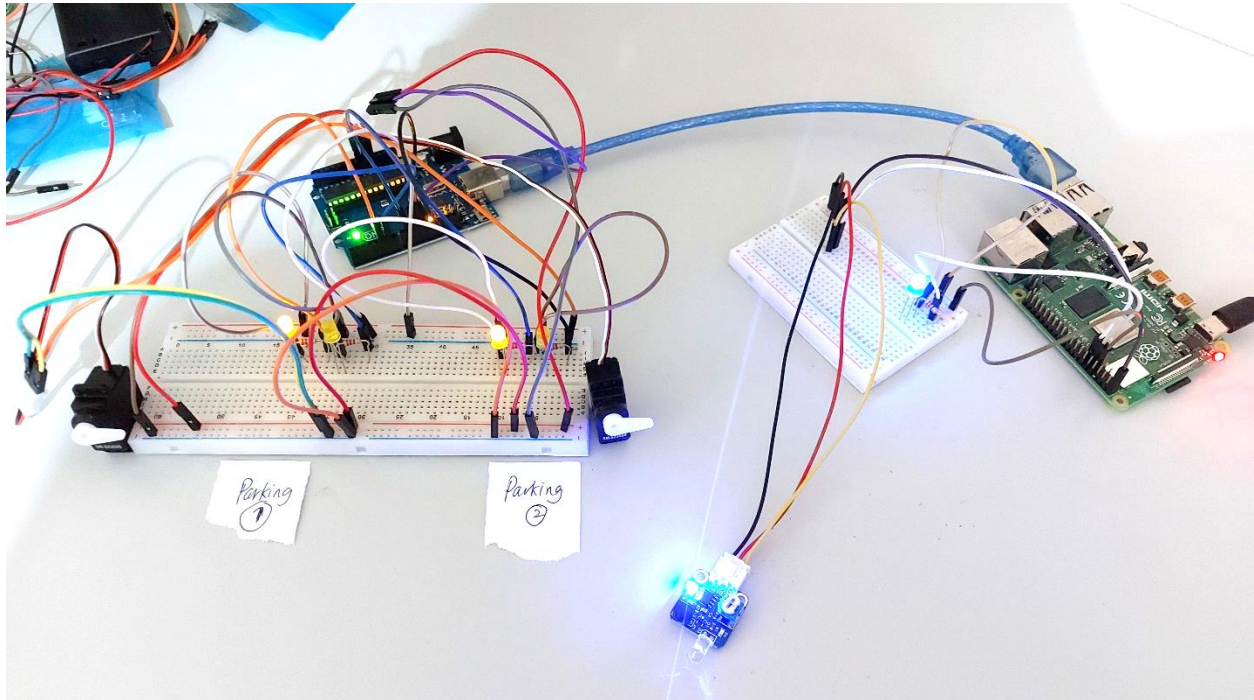
3.1. Raspberry Pi4 Setup



3.2. Arduino Setup



3.3. Raspberry Pi 4 and Arduino together



4. Source code

Full **source code** and other files are available in [Github](https://github.com/hemantramphul/Smart-Parking) which is 100% executable, and each line is explained.

4.1. Download link

Download link:

<https://github.com/hemantramphul/Smart-Parking>