Programming Sphero Mini using Python

using Spherov2 API

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***Index Terms*—Sphero mini Droid**

Fig 1: sphero mini

I. Introduction

THe Sphero Mini is an an app enabled droid and also be programmed to work in required manner. Users could connect the iconic Star Wars droid to their smart device, using Sphero Mini to navigate the real world and explore holographic environments like the Millennium Falcon. Equipped with an integrated speaker system and colorful LEDs, Sphero Mini reacted to Star Wars films, too. Sphero robots aren't just toys – they are programmable robots that are great for learning about computer science! . This sphero Mini has various built-in functionalities with gears , movements and sensors. Mini can turn head using built-in gears and the head can also emit lights . just like in the movies, this Mini has a third leg that fully retracts inside the body when he's standing still and extends when he's moving about.Sphero's Mini moves in a very realistic fashion, driving along the ground in tripod mode and also waddling side to side when standing with two legs. Mini also has senors from which it takes input to calculate the desired output .
In this project I have used Sphero Edu API to program our sphero Mini . The requirements for this API to work is have low powered Bluetooth Adapter PC and Python version greater than or equal to 3.7 . I started my project by installing Spherov2 and Bleak . In this project I have worked with the leds and the movements of Sphero Mini .

I will be using Sphero Droid mini which has same gears and senors as R2D2 regardless of it's size and appearance . Sphero mini too uses same Spherov2 APIs for it's functions . Sphero Droid mini too have same functionalities like R2D2 . Therefore if I am referring to R2d2 in context it also implements to Sphero Droid mini too .

II. Action Performed by Droid

In task 1 , I was assigned with tasks and functions to be performed by Sphero droid . This function enabled me to learn more about the functionalities of Sphero Droid and I worked with sensors of Sphero Droid .Sphero Droid has sensors and gears which enables them to do various task . Sphero Droid can perform various task such as moving in different directions with help of gears and sensors . Sphero Droid have in-build led lights which emits lights . The functions such as moving and emitting light can be performed using Python API such as Spherov2 API . Sphero Droid uses Bluetooth to get connection with the controller such as my laptop. Actions which are performed by Shero Droid are as follows :

A. Lists and For loops

In this task Sphero Droid was programmed to execute series of roll commands based on list of triples . This function contained data for Sphero Droid to move in direction , speed and duration specified . this tasked was specified to use Lambda function to sort the given data ofspeed and duration. After execution and sorting Sphero Droid moved accordingly to sorted data . I used Square Trajectory to give data to sphero in which , the data got sorted and the droid moved in shape of square.

B. Drive Regular Polygon(Function)

In this task Sphero Droid was programmed to make any regular in given number of n sides .So after programming the Sphero Droid made movements resulting in shapes.when I gave n=3 as input it made shape of triangle , than I gave n=4 which gave square as result and therefore giving n=5 made a shape of Pentagon . this task help me to understand how Sphero Droid would react on giving it n number of data .

C. Drawing Regular Shapes(Function)

I had to program a function that drive Sphero Droid into making any two shapes. In this function it would take any n number of sides and would make a shape. I gave Sphero Droid n=4 , so it made a square shape and for n=3 droid moved in directions resulting in triangle shape .

D. Dictionaries(RGB LED)

In this task , I used Python dictionary of RGB LEDs with its key-pair values. then I mapped it with names which were in form of string . I had to a function for Sphero Droid to emit the same colour of the light which is specified during the run . I had to function Sphero Droid in such a way that it had to emit light in front and back , with color specified in input . I gave the colour red for front led as the input to the Sphero Droid and the Sphero Droid emitted red color light from the front. And I gave #008000 as input for back light and Sphero Droid emitted green light from the back .

Fig 2 : led blinking

E. Driving with the Keyboard Arrow Keys

In this task , I used keyboard module of python to program function such a way that the Sphero Droid would react when pressed the arrow keys . Up arrow key is used to increase the speed of the droid and Down arrow key is used for decreasing the speed of the Sphero Droid . Left arrow Key is used to decrease the heading / angle of the Sphero Droid and Right arrow key is used to increase the heading / angle of the Sphero Droid . When I executed the function on Sphero Droid , it moved forword with increasing in speed when I pressed Up arrow key and the speed decreased when I pressed Down arrow key. When I pressed Left arrow key its angle decreased and when I pressed Right the angle of the Sphero Droid increased .

F. Sending a Message via Morse Code

For this task I created a function to convert any kind of input string should convert into morse code , basically i made a function to convert any given string to morse code . I made a second function to take that morse code and use it to emit light from Sphero Droid in such a way that it reads out the morse code. In practical ways I gave " sahil gidwani " as input to the function which converted it into " ... .- ....-.. –. .. -.. .– .- -. .. " this then was emitted from my Droid , like for example ’ . ’ was represented by led lighting up for 1 sec and for ’ - ’ led lighted up for 3s . This is how morse code message was produced by Sphero droid using it’s leds .

Fig 3: sphero mini Dorid

III. 3. Explanation of each action as implemented in Task-1

For each sub task functions were written by me to be executed according to the tasks given . I have used Python language and it’s APIs for the code . Spherov2 API is being used by me to code for my Sphero Droid . Movements , Direction as well as Duration can be controlled through the code . As well as LEDs of the Sphero Droid could also be coded to perform particular task . For each task I imported two modules , which are as follows :

```
from spherov2 import scanner
```

The scanner module was used to scan near by Sphero Droid

```
    from spherov2.sphero_edu import SpheroEduAPI
```

The SpheroEduAPI is used to import SpheroAPIs

A. Lists and For loops

In this task I had to execute series of roll commands based on a list of triples and I had to write a lumbda function to sort the roll commands by duration and then by speed
Following is the explanation of the code :

```
    toy = scanner.find_toy()
with SpheroEduAPI(toy) as droid:
```

Above code is used to scan the nearby Sphero and start of the new droid function .

```
    roll_commands = [(0, 5, 1), (90, 5, 3),
    (180, 5, 2), (270, 5, 4)]
```

This is the list of roll commands

```
sortedbyduration=
sorted(roll_commands,key=lambda x:x[2])
sortedbyspeed=
sorted(sortedbyduration,key=lambda x:x[1])
```

FirstLine : sorting the roll commands by duration
SecondLine : sorting the roll commands by speed

```
    for i in sortedbyspeed: // for loop

        droid.roll(i[0],i[1],i[2])
```

For loop is being use to run till the data is available .
droid.roll(i[0],i[1],i[2]) is used to roll for each set of sorted data .

The above code gave the desired output by sorting of data and the movement of Sphero Droid was according to the task given .

B. Drive Regular Polygon

In this task I had to drive Sphero Droid in shape of polygon by following Trajectory with n sides . Therefore I had to make a shape of any regular polygon with give n number of sides in input .
following is the code explanation :

```
    toy = scanner.find_toy()
with SpheroEduAPI(toy) as droid:
```

Above code is used to scan the nearby Sphero and start of the new droid function .

```
    def shape_of_polygon( n:int, speed:int):
```

There is a function with two arguments which are n(sides) and speed , both are int .

```
    for x in range(n):
// this loop will work n number of times

            droid.set_speed(speed)
// .set_speed() is used to set speed of
//the droid in sec

            droid.spin(360/n,1)
//.spin() is used to take angle and duration
            shape_of_polygon(5,1)

//this is used to call the function
//shape_of_polygon
```

Above snippet is explained in comments .

In above example I have called function and send n as 5 which will create a desired shape . After executing the code the Sphero Droid made a pentagon shape .

C. Drawing Regular Shapes

In this task I had to drive Sphero Droid in 2 shape by following Trajectory with n sides . I had make a shape using n=4 number as my sides and using n=3 .

```
    with SpheroEduAPI(toy) as droid:
def shape_square( n=4, speed=1):
for x in range(n):
print(n,speed)
droid.set_speed(speed)
droid.spin(90,2)
```

Tn this i have taken n as 4 and speed as 1 , this will create a square in at speed of 1 sec .

```
    def shape_triangle(n=3, speed=1):
for x in range(n):
print(n,speed)
droid.set_speed(speed)
droid.spin(90,2)
```

Tn this i have taken n as 3 and speed as 1 , this will create a triangle in at speed of 1 sec .

```
    shape_square()
shape_triangle()
```

The above code will create square and triangle shapes .Therefore this will

D. Dictionaries (RGB LED)

In this task I had to used python dictionaries to match color name to rgb code in the table . I had to implement functions to change the light color according to the input . I had to make a function to change hex to rgb
following is the code :

```
    toy = scanner.find_toy()
with SpheroEduAPI(toy) as droid:
```

Above code is used to scan the nearby Sphero and start of the new droid function .

```
    def set_lights(color_leds, which_light):
```

This function takes two arguments one for color of the leds and other for lights.

```
    if color_leds.startswith('#'):
        color1=hex_to_rgb(color_leds)
        print(color_leds)
     else: color1= color_names_to_rgb[color_leds]
     print(color_leds)
```

The if condition check if input color is hex or string . if it's string it will go through a function hex-to-rgb where hex will convert to rgb . else if it's name it will get the rgb value from dictionaries .

```
    if which_light == 'front':
        droid.set_front_led(color1)
     elif which_light=='back' :
```

```
        droid.set_back_led(color1)
     else :
        droid.set_front_led(color1)
        droid.set_back_led(color1)
```

this statements will check if the the input is for front , back or both and will trun on the led with the desired color .

```
    def hex_to_rgb(hex):
  return tuple(int(hex[i:i+2], 16) for i in (0, 2, 4))
```

This function is used for converting hex to rgb

```
    set_lights( '"#ffffff"', 'both' )
```

In this I am passing #ffffff and both . so first #ffffff will change to rb(255,255,255) and both of the leds will emit white light .

E. Driving with the Keyboard Arrow Keys

In this task I have imported python keyboard module . I have used this module to control actions of the Sphero Droid Following is the code:

```
    toy = scanner.find_toy()
with SpheroEduAPI(toy) as droid:
```

Above code is used to scan the nearby Sphero and start of the new droid function .

```
    print('Press ESC key to exit...')
        while True:
            if keyboard.is_pressed(1):
                return
```

Above code condition is being check if user presses 1 which is esc the program will end .

```
    elif keyboard.is_pressed(72):

droid.roll(heading,
speed+speed_delta,duration)
```

Above code condition is being check if user presses 72 which is Up arrow , the droid will move forward with increase in speed

```
     elif keyboard.is_pressed(80):
droid.roll(heading,
speed-speed_delta,duration)
```

Above code condition is being check if user presses 80 which is Down arrow , then Droid will decrease the speed .

```
    elif keyboard.is_pressed(75):
droid.roll(heading-heading_delta,
speed+speed_delta,duration)
```

Above code condition is being check if user presses 75 which is Left arrow , then Droid will decrease the angle .

```
    elif keyboard.is_pressed(77):
droid.roll(heading+heading_delta,
speed+speed_delta,duration)
```

Above code condition is being check if user presses 75 which is right arrow , then Droid will increase the angle .

This is how I was able to control the Sphero droid using the keyboard keys when pressed. I used were the arrows .

F. Sending a Message via Morse Code

In this task , I made a function which would convert any string to Morse code . Than , I made a function that would make leds blink to produce morse message . For Morse code I have used dictionary made for morse code .
following is the code for morse code :

```
     toy = scanner.find_toy()
with SpheroEduAPI(toy) as droid:
```

Above code is used to scan the nearby Sphero and start of the new droid function .

```
# function to encode plain English text
to morse code
def to_morse_code(english_plain_text):
morse_code = ''
for char in english_plain_text:
# checking for space
# to add single space after every character
and double space after every word
if char == ' ':
morse_code += '  '
else:
# adding encoded morse code to the result
morse_code += CHARS_TO_MORSE_CODE_MAPPING[char.uppe
return morse_code

morse_code = to_morse_code(
    'help'
)
```

Explanation of above code is in comments itself. Now , above code will generate morse code needed for droid to blink message .

```
for i in morse_code:
if i=='.':
 droid.fade(Color(24, 242, 82), Color(0,0,0), 1)
print('.')
```

```
elif  i=='-':
droid.fade(Color(242, 24, 82), Color(0,0,0), 3)
print('-')
```

For loop will run till the end of the character in morse code . First condition will check if it's ' . ' and Second condition will check if it's ' - ' . If the condition for ' . ' is true the led will blink for 1 sec . If the condition for' - ' is true the led will blink for 3 sec. **I have used FADE function from API as it was suitable for me to work on my Droid** .Therefore above program will bring morse code in form of blinking .

Fig 4: sphero mini with kit i/p

IV. Recommendations to improve R2D2

Sphero Droid was developed for mobile first use and Sphero Droid has less sensor built it . Sphero will need more gears and sensor to work smoothly.
Sphero Droid needs Spherov2 API to work on . Spherov2 APIs have limited function to work on.
Due to limited pre made functions Droid it can be only be worked on those .
Sphero droid have very less documentation .
Due to less documentation Sphero Droid can not be fully programmed .
Manufacturing of R2D2 Droid by Official has been stopped.
Sphero Droid doesn't work as expected . Like it moves a little clumsy when it moves from one place to other .
It is limited in terms of sensors since it only has 3D accelerator .
It should also have ability to detect objects so that it doesn't crash into something .

V. References

[1] https://sphero.com/pages/legacy-products
[2] https://www.youtube.com/watch?v=rasZOVx6wx0t=71s