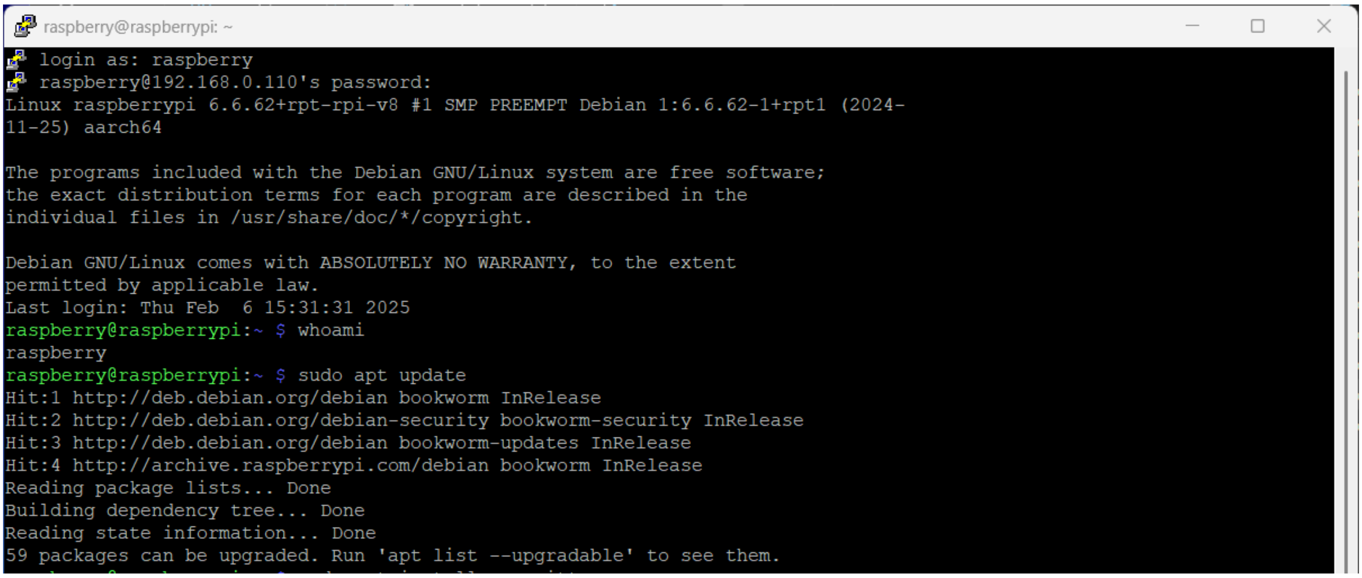
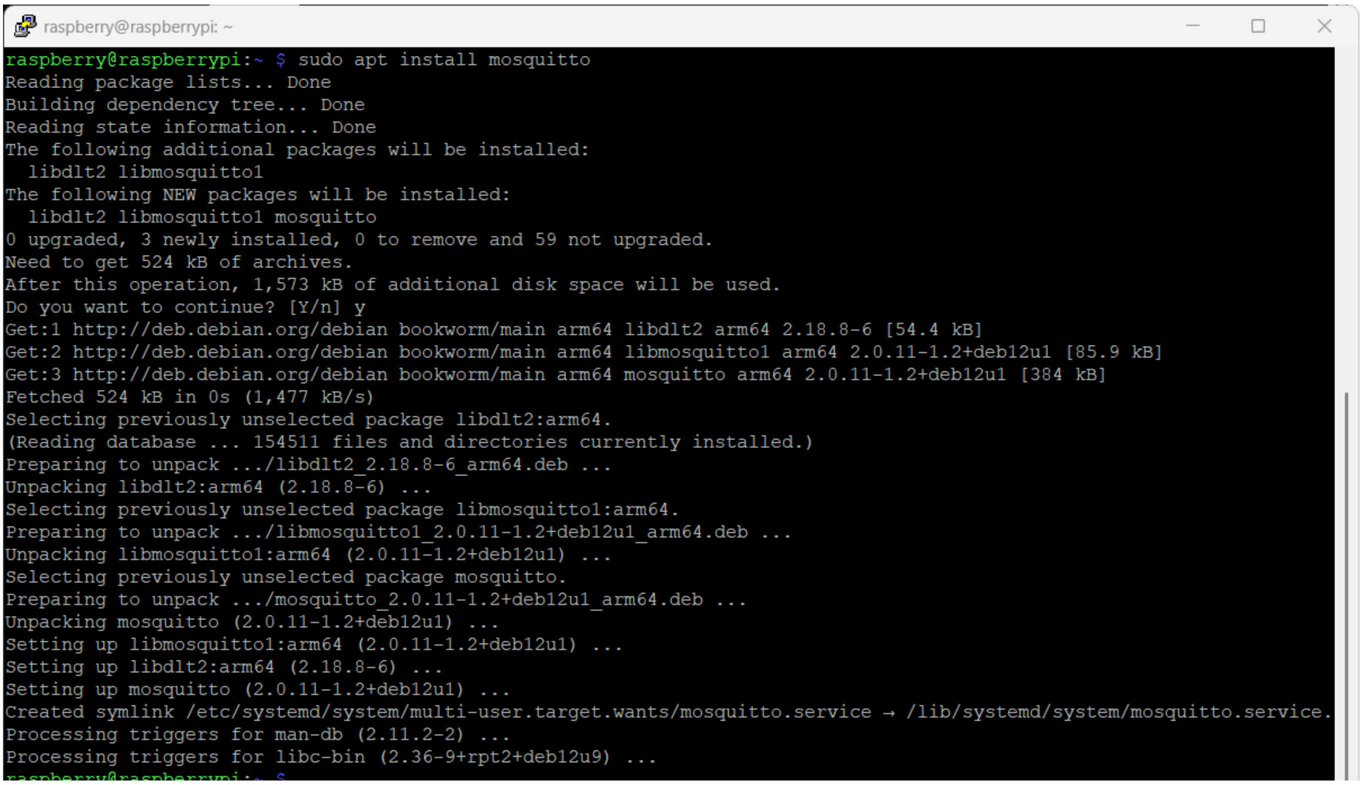
Lab05 (MQTT) Screenshots

1. Install and Configure the MQTT Broker on a Raspberry Pi 3:



```
login as: raspberry
raspberry@192.168.0.110's password:
Linux raspberrypi 6.6.62+rpt-rpi-v8 #1 SMP PREEMPT Debian 1:6.6.62-1+rpt1 (2024-
11-25) aarch64

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Thu Feb  6 15:31:31 2025
raspberry@raspberrypi:~ $ whoami
raspberry
raspberry@raspberrypi:~ $ sudo apt update
Hit:1 http://deb.debian.org/debian bookworm InRelease
Hit:2 http://deb.debian.org/debian-security bookworm-security InRelease
Hit:3 http://deb.debian.org/debian bookworm-updates InRelease
Hit:4 http://archive.raspberrypi.com/debian bookworm InRelease
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
59 packages can be upgraded. Run 'apt list --upgradable' to see them.
```

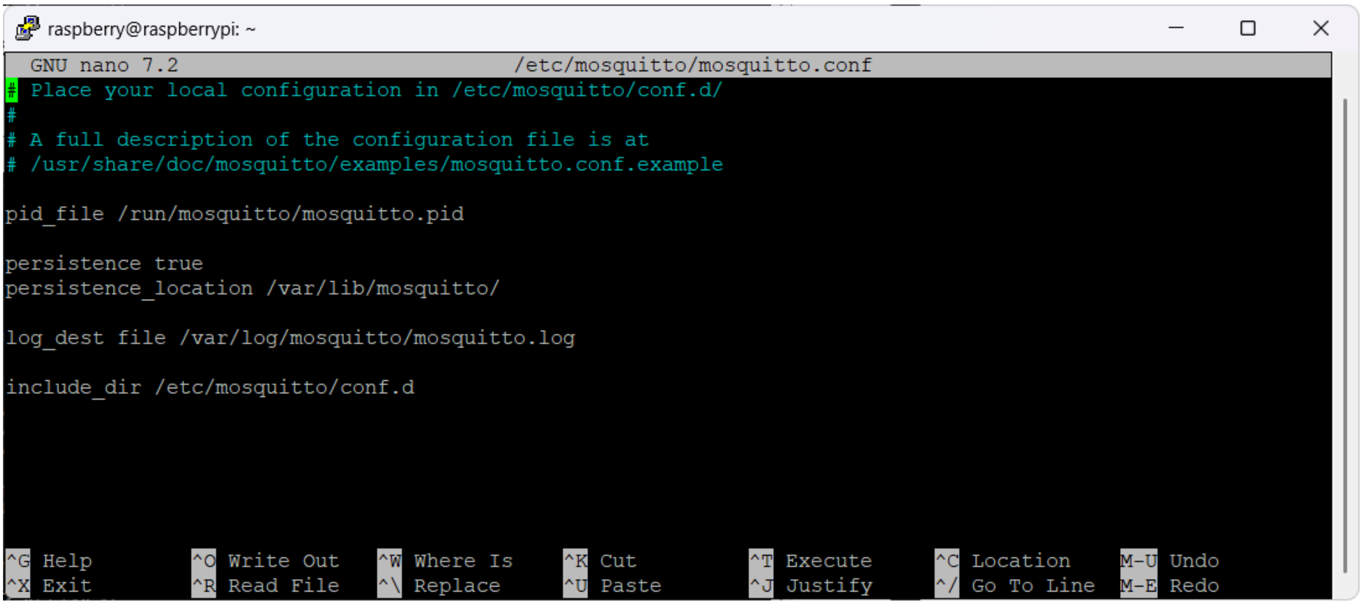
Fig. 1. Screenshot of updating the Raspberry Pi's package list



```
raspberry@raspberrypi:~ $ sudo apt install mosquitto
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
  libdlt2 libmosquitto1
The following NEW packages will be installed:
  libdlt2 libmosquitto1 mosquitto
0 upgraded, 3 newly installed, 0 to remove and 59 not upgraded.
Need to get 524 kB of archives.
After this operation, 1,573 kB of additional disk space will be used.
Do you want to continue? [Y/n] y
Get:1 http://deb.debian.org/debian bookworm/main arm64 libdlt2 arm64 2.18.8-6 [54.4 kB]
Get:2 http://deb.debian.org/debian bookworm/main arm64 libmosquitto1 arm64 2.0.11-1.2+deb12u1 [85.9 kB]
Get:3 http://deb.debian.org/debian bookworm/main arm64 mosquitto arm64 2.0.11-1.2+deb12u1 [384 kB]
Fetched 524 kB in 0s (1,477 kB/s)
Selecting previously unselected package libdlt2:arm64.
(Reading database ... 154511 files and directories currently installed.)
Preparing to unpack .../libdlt2_2.18.8-6_arm64.deb ...
Unpacking libdlt2:arm64 (2.18.8-6) ...
Selecting previously unselected package libmosquitto1:arm64.
Preparing to unpack .../libmosquitto1_2.0.11-1.2+deb12u1_arm64.deb ...
Unpacking libmosquitto1:arm64 (2.0.11-1.2+deb12u1) ...
Selecting previously unselected package mosquitto.
Preparing to unpack .../mosquitto_2.0.11-1.2+deb12u1_arm64.deb ...
Unpacking mosquitto (2.0.11-1.2+deb12u1) ...
Setting up libmosquitto1:arm64 (2.0.11-1.2+deb12u1) ...
Setting up libdlt2:arm64 (2.18.8-6) ...
Setting up mosquitto (2.0.11-1.2+deb12u1) ...
Created symlink /etc/systemd/system/multi-user.target.wants/mosquitto.service → /lib/systemd/system/mosquitto.service.
Processing triggers for man-db (2.11.2-2) ...
Processing triggers for libc-bin (2.36-9+rpt2+deb12u9) ...
```

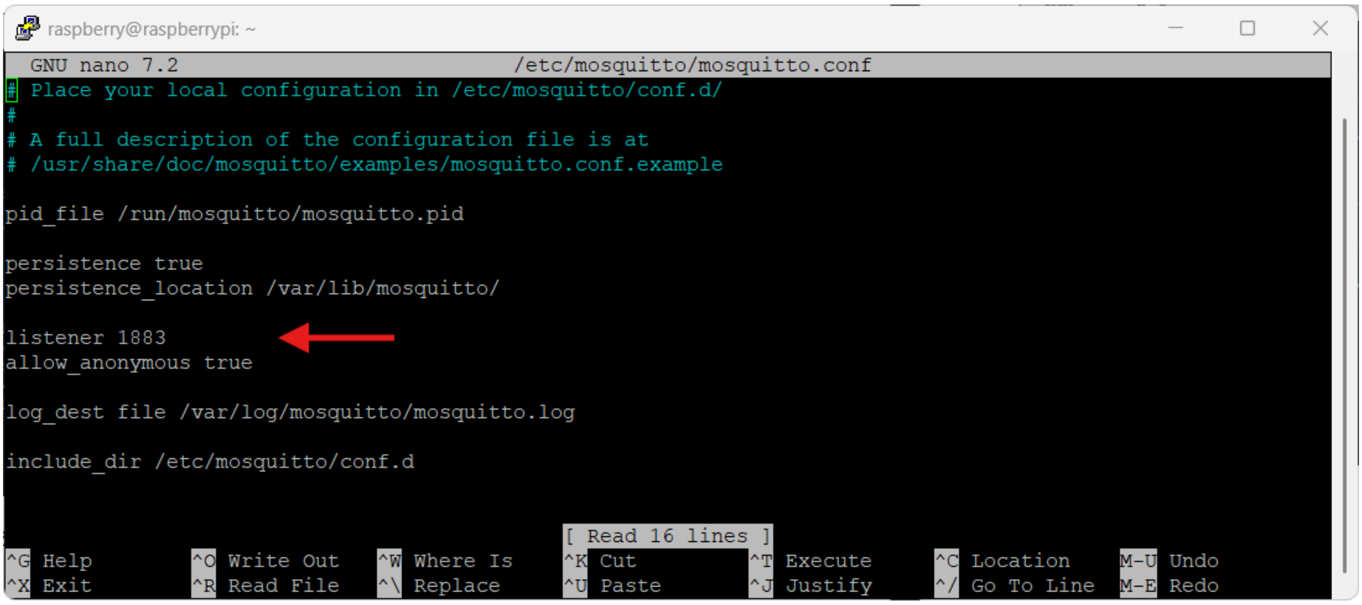
Fig. 2. Screenshot of installing the Mosquitto MQTT broker

Lab05 (MQTT) Screenshots



```
  GNU nano 7.2                        /etc/mosquitto/mosquitto.conf
# Place your local configuration in /etc/mosquitto/conf.d/
#
# A full description of the configuration file is at
# /usr/share/doc/mosquitto/examples/mosquitto.conf.example

pid_file /run/mosquitto/mosquitto.pid

persistence true
persistence_location /var/lib/mosquitto/

log_dest file /var/log/mosquitto/mosquitto.log

include_dir /etc/mosquitto/conf.d




^G Help          ^O Write Out     ^W Where Is      ^K Cut           ^T Execute       ^C Location      M-U Undo
^X Exit          ^R Read File     ^\ Replace       ^U Paste         ^J Justify       ^/ Go To Line    M-E Redo
```

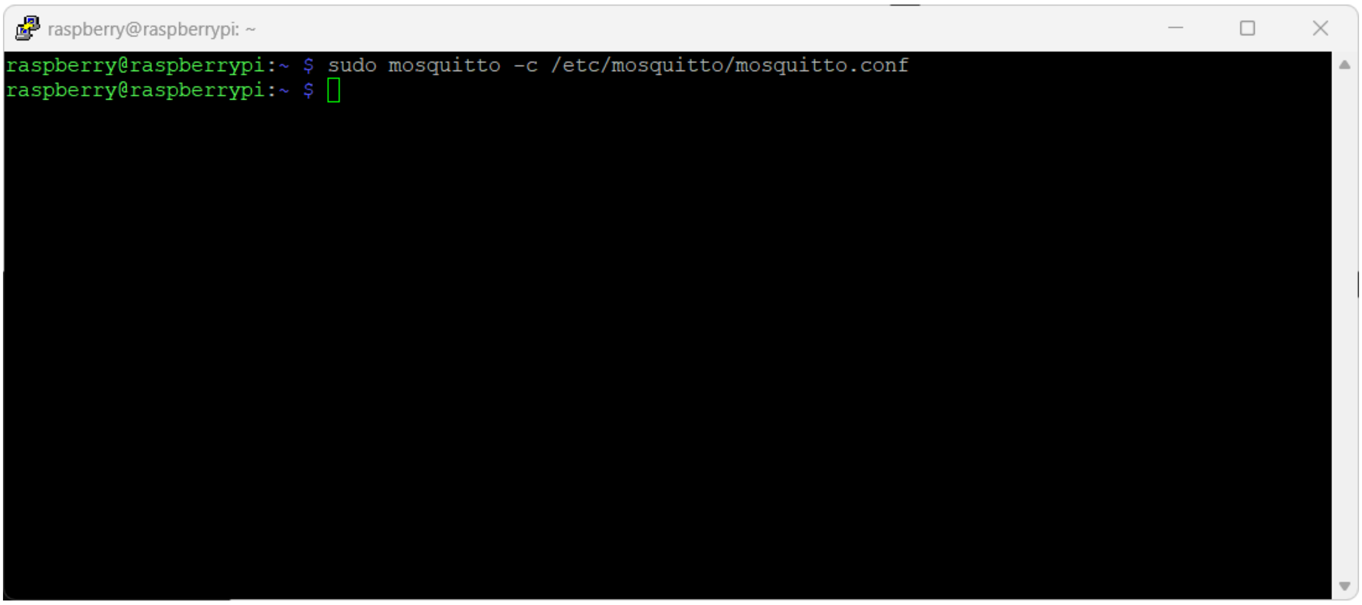
Fig. 3. Screenshot of Mosquitto Configuration File



```
  GNU nano 7.2                        /etc/mosquitto/mosquitto.conf
# Place your local configuration in /etc/mosquitto/conf.d/
#
# A full description of the configuration file is at
# /usr/share/doc/mosquitto/examples/mosquitto.conf.example

pid_file /run/mosquitto/mosquitto.pid

persistence true
persistence_location /var/lib/mosquitto/

listener 1883
allow_anonymous true

log_dest file /var/log/mosquitto/mosquitto.log

include_dir /etc/mosquitto/conf.d


                                                  [ Read 16 lines ]
^G Help          ^O Write Out     ^W Where Is      ^K Cut           ^T Execute       ^C Location      M-U Undo
^X Exit          ^R Read File     ^\ Replace       ^U Paste         ^J Justify       ^/ Go To Line    M-E Redo
```

Fig. 4. Screenshot of Mosquitto Configuration File (after allowing broker to listen to port 1883 and allow anonymous clients to connect and use the MQTT broker)

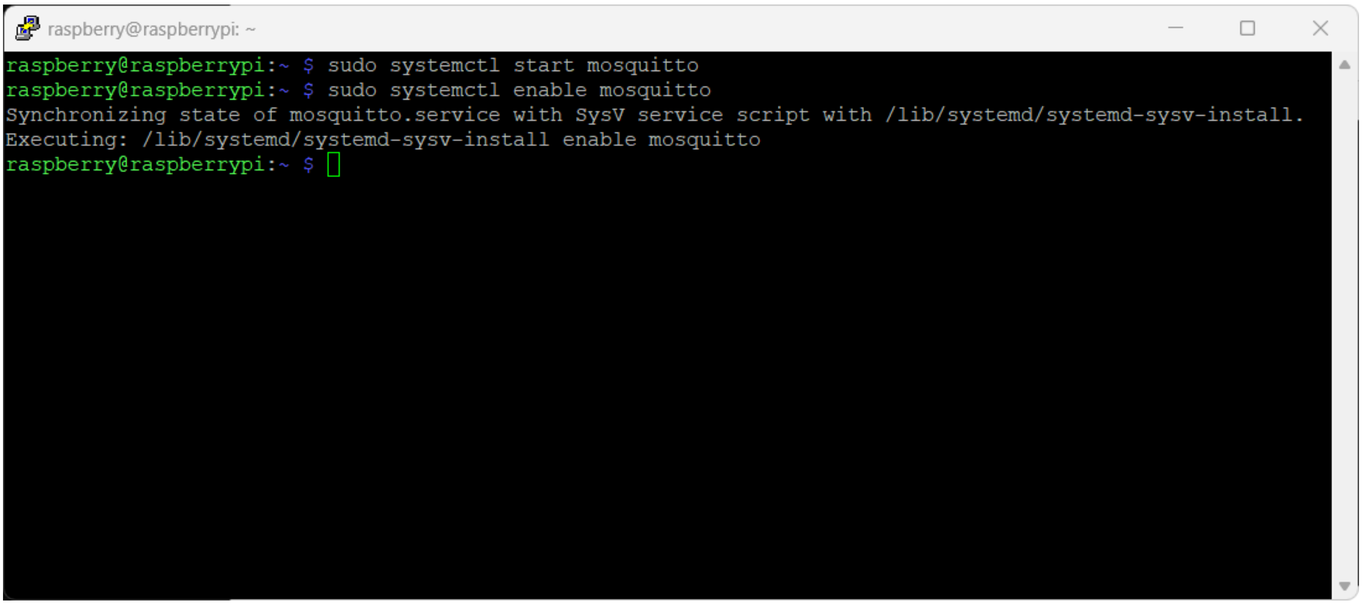
Lab05 (MQTT) Screenshots



```
raspberry@raspberrypi:~ $ sudo mosquitto -c /etc/mosquitto/mosquitto.conf
raspberry@raspberrypi:~ $ 
```

Fig. 4. Screenshot of starting mosquito broker manually via command line

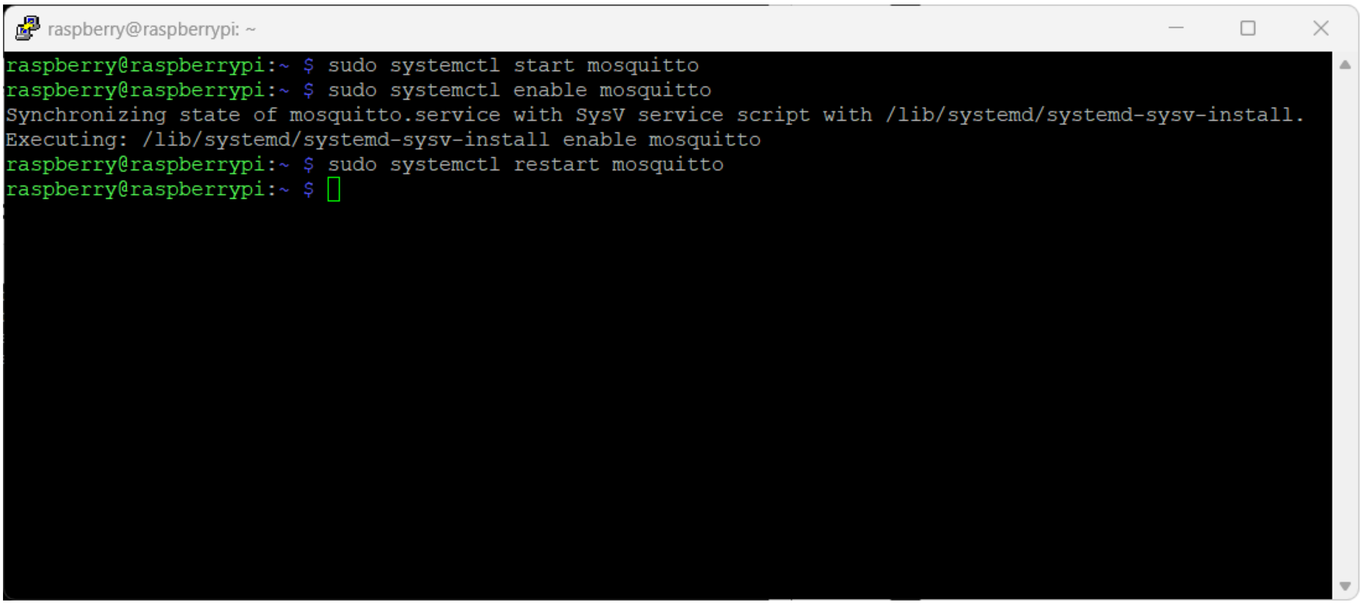
2. Enable Mosquitto Broker to run on boot



```
raspberry@raspberrypi:~ $ sudo systemctl start mosquitto
raspberry@raspberrypi:~ $ sudo systemctl enable mosquitto
Synchronizing state of mosquitto.service with SysV service script with /lib/systemd/systemd-sysv-install.
Executing: /lib/systemd/systemd-sysv-install enable mosquitto
raspberry@raspberrypi:~ $ 
```

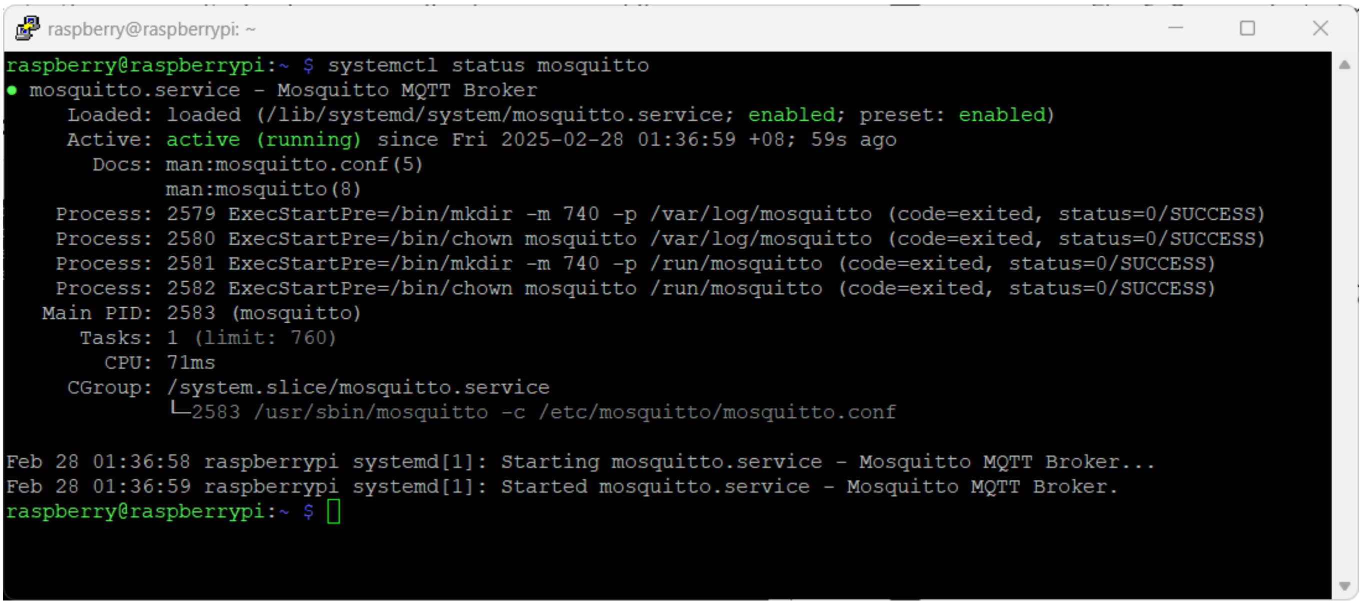
Fig. 5. Screenshot of starting and enabling Mosquitto to run on boot

Lab05 (MQTT) Screenshots



```
raspberry@raspberrypi:~ $ sudo systemctl start mosquitto
raspberry@raspberrypi:~ $ sudo systemctl enable mosquitto
Synchronizing state of mosquitto.service with SysV service script with /lib/systemd/systemd-sysv-install.
Executing: /lib/systemd/systemd-sysv-install enable mosquitto
raspberry@raspberrypi:~ $ sudo systemctl restart mosquitto
raspberry@raspberrypi:~ $ 
```

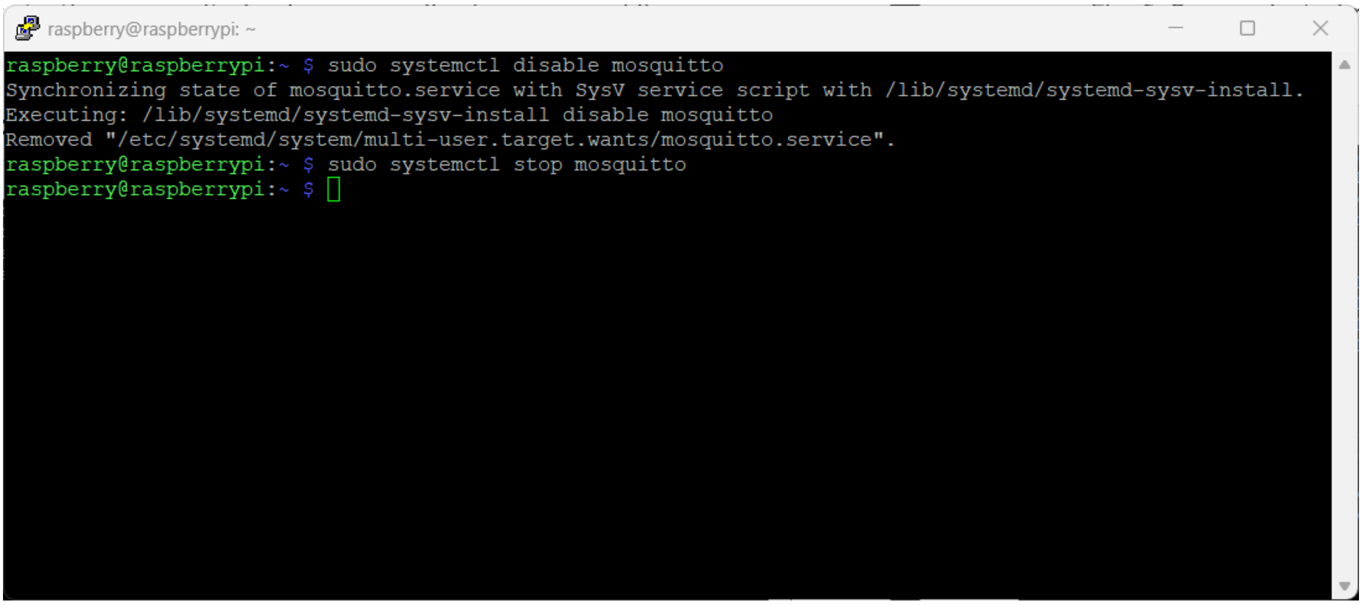
Fig. 6. Screenshot of restarting Mosquitto Broker to apply the new configuration



```
raspberry@raspberrypi:~ $ systemctl status mosquitto
● mosquitto.service - Mosquitto MQTT Broker
     Loaded: loaded (/lib/systemd/system/mosquitto.service; enabled; preset: enabled)
     Active: active (running) since Fri 2025-02-28 01:36:59 +08; 59s ago
       Docs: man:mosquitto.conf(5)
             man:mosquitto(8)
    Process: 2579 ExecStartPre=/bin/mkdir -m 740 -p /var/log/mosquitto (code=exited, status=0/SUCCESS)
    Process: 2580 ExecStartPre=/bin/chown mosquitto /var/log/mosquitto (code=exited, status=0/SUCCESS)
    Process: 2581 ExecStartPre=/bin/mkdir -m 740 -p /run/mosquitto (code=exited, status=0/SUCCESS)
    Process: 2582 ExecStartPre=/bin/chown mosquitto /run/mosquitto (code=exited, status=0/SUCCESS)
   Main PID: 2583 (mosquitto)
      Tasks: 1 (limit: 760)
        CPU: 71ms
     CGroup: /system.slice/mosquitto.service
             └─2583 /usr/sbin/mosquitto -c /etc/mosquitto/mosquitto.conf

Feb 28 01:36:58 raspberrypi systemd[1]: Starting mosquitto.service - Mosquitto MQTT Broker...
Feb 28 01:36:59 raspberrypi systemd[1]: Started mosquitto.service - Mosquitto MQTT Broker.
raspberry@raspberrypi:~ $ 
```

Fig. 7. Screenshot of Mosquitto running status

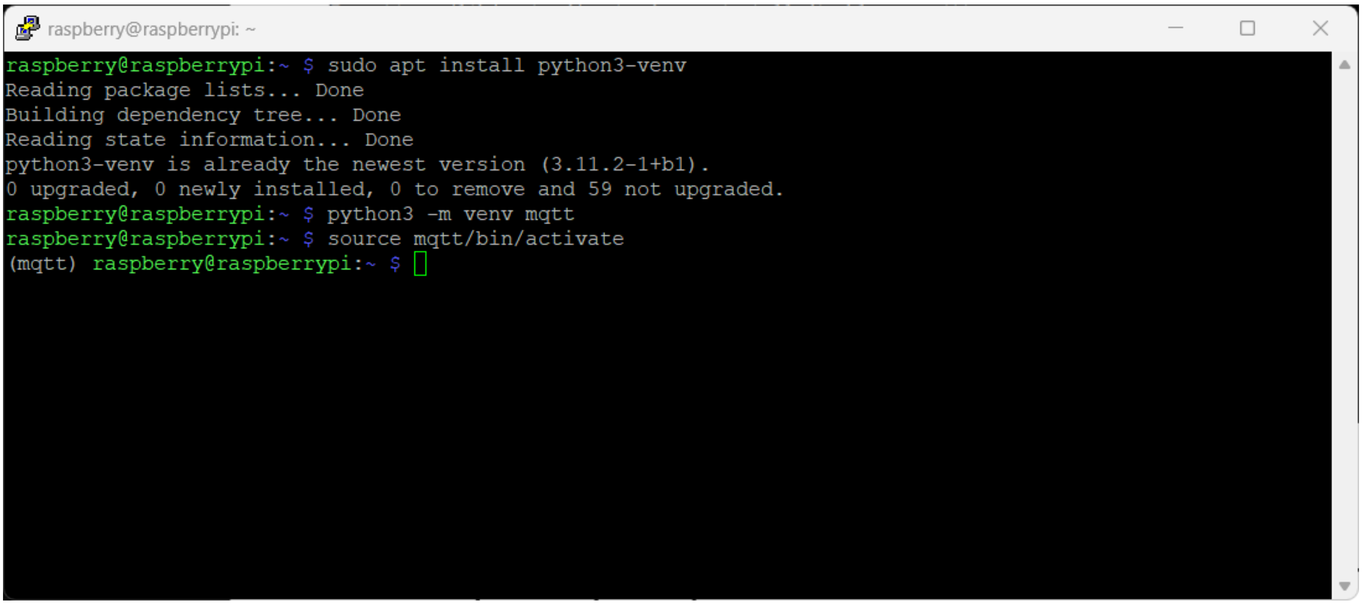
Lab05 (MQTT) Screenshots



```
raspberry@raspberrypi:~ $ sudo systemctl disable mosquitto
Synchronizing state of mosquitto.service with SysV service script with /lib/systemd/systemd-sysv-install.
Executing: /lib/systemd/systemd-sysv-install disable mosquitto
Removed "/etc/systemd/system/multi-user.target.wants/mosquitto.service".
raspberry@raspberrypi:~ $ sudo systemctl stop mosquitto
raspberry@raspberrypi:~ $ 
```

Fig. 8. Screenshot of disabling and stopping Mosquitto MQTT broker

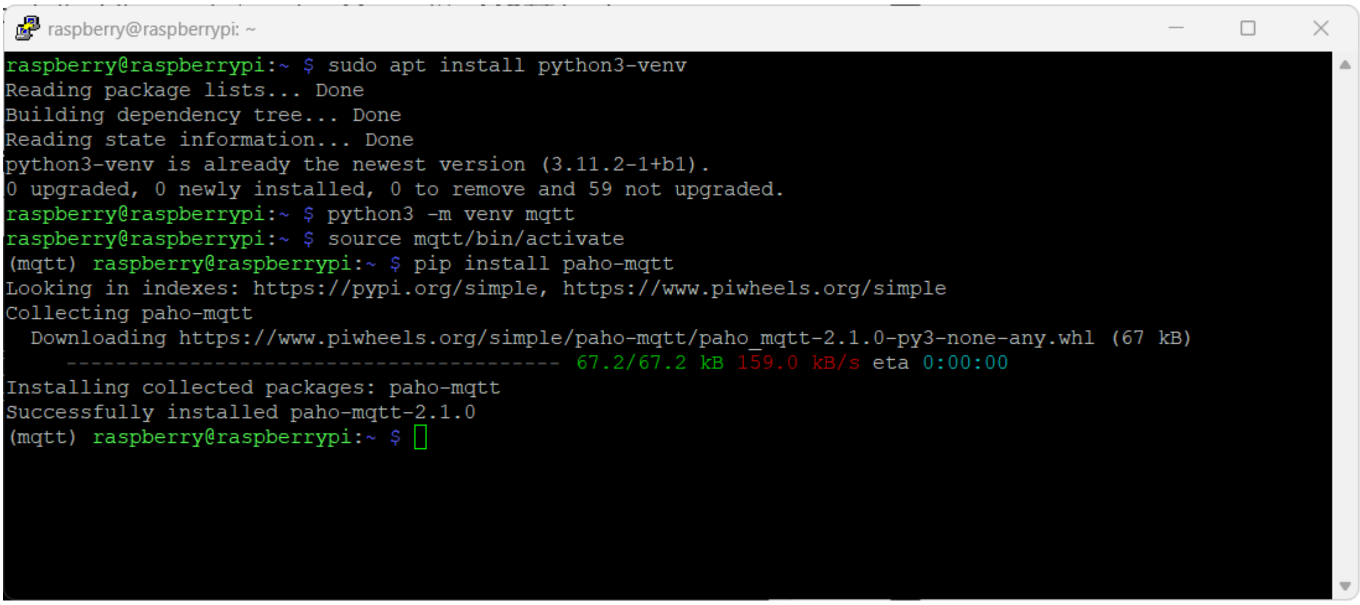
3. Install and Configure the MQTT Client (Publisher and/or Subscriber) on another Raspberry Pi 3



```
raspberry@raspberrypi:~ $ sudo apt install python3-venv
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
python3-venv is already the newest version (3.11.2-1+b1).
0 upgraded, 0 newly installed, 0 to remove and 59 not upgraded.
raspberry@raspberrypi:~ $ python3 -m venv mqtt
raspberry@raspberrypi:~ $ source mqtt/bin/activate
(mqtt) raspberry@raspberrypi:~ $ 
```

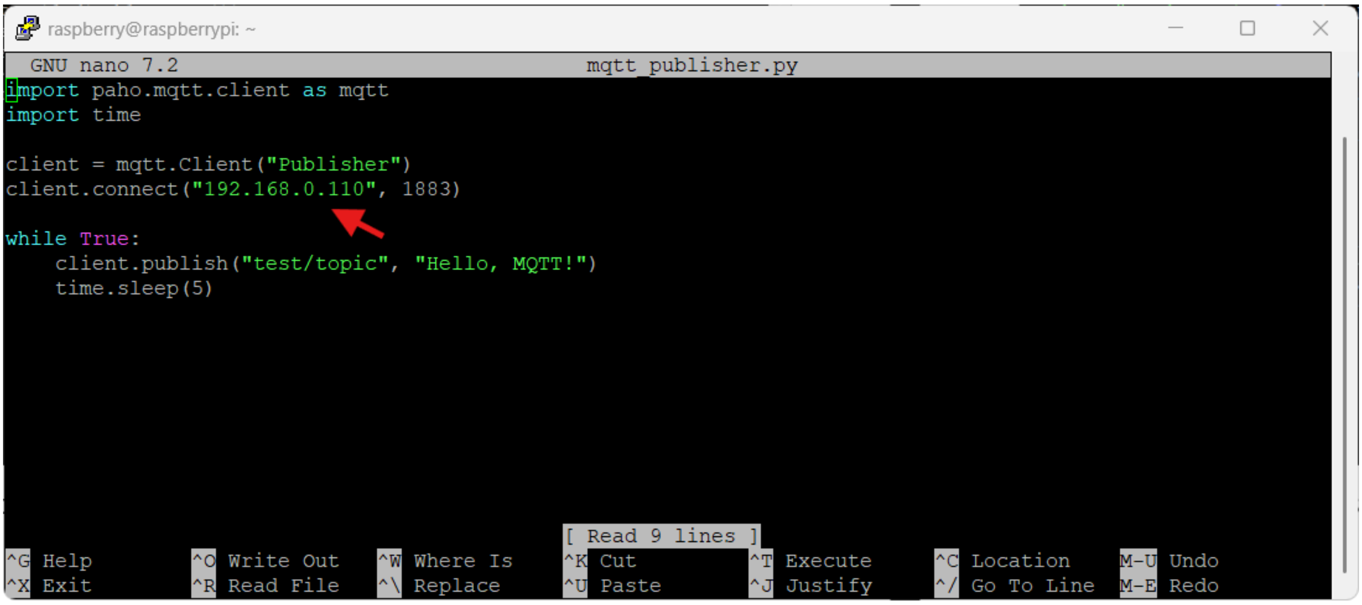
Fig. 9. Screenshot of activating the Virtual Environment `mqtt`

Lab05 (MQTT) Screenshots

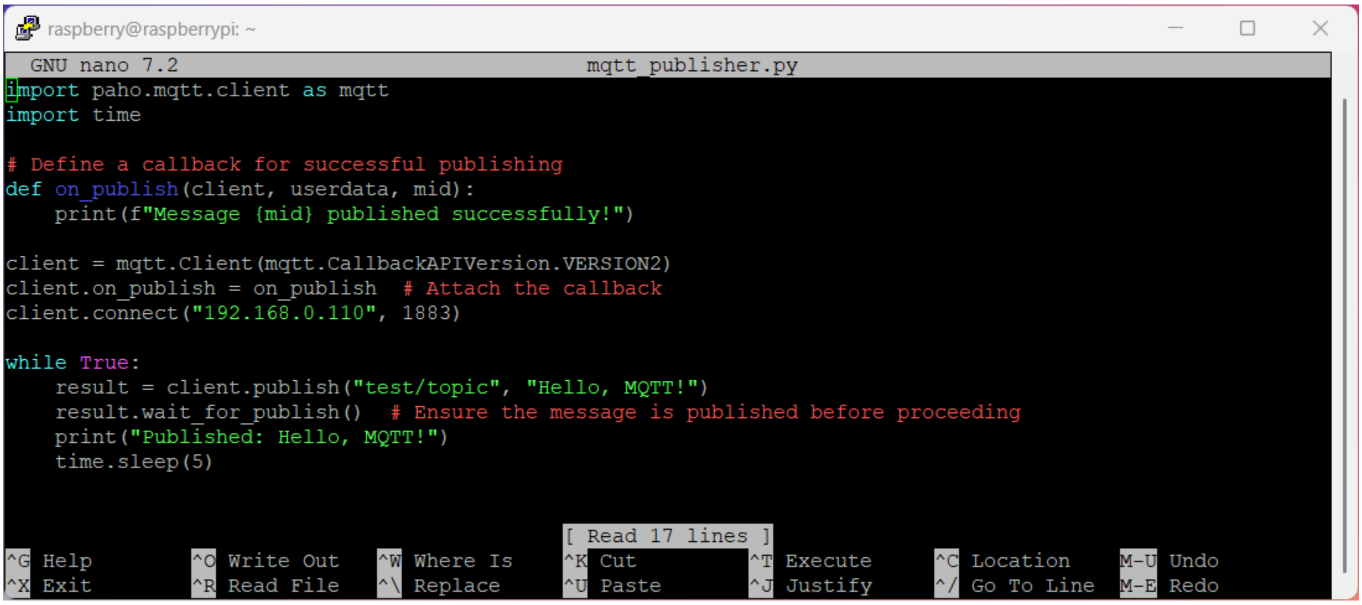


```
raspberry@raspberrypi:~ $ sudo apt install python3-venv
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
python3-venv is already the newest version (3.11.2-1+b1).
0 upgraded, 0 newly installed, 0 to remove and 59 not upgraded.
raspberry@raspberrypi:~ $ python3 -m venv mqtt
raspberry@raspberrypi:~ $ source mqtt/bin/activate
(mqtt) raspberry@raspberrypi:~ $ pip install paho-mqtt
Looking in indexes: https://pypi.org/simple, https://www.piwheels.org/simple
Collecting paho-mqtt
  Downloading https://www.piwheels.org/simple/paho-mqtt/paho_mqtt-2.1.0-py3-none-any.whl (67 kB)
     ---------------------------------------- 67.2/67.2 kB 159.0 kB/s eta 0:00:00
Installing collected packages: paho-mqtt
Successfully installed paho-mqtt-2.1.0
(mqtt) raspberry@raspberrypi:~ $ 
```

Fig. 10. Screenshot of installation of Python Paho MQTT library for both publisher and subscriber

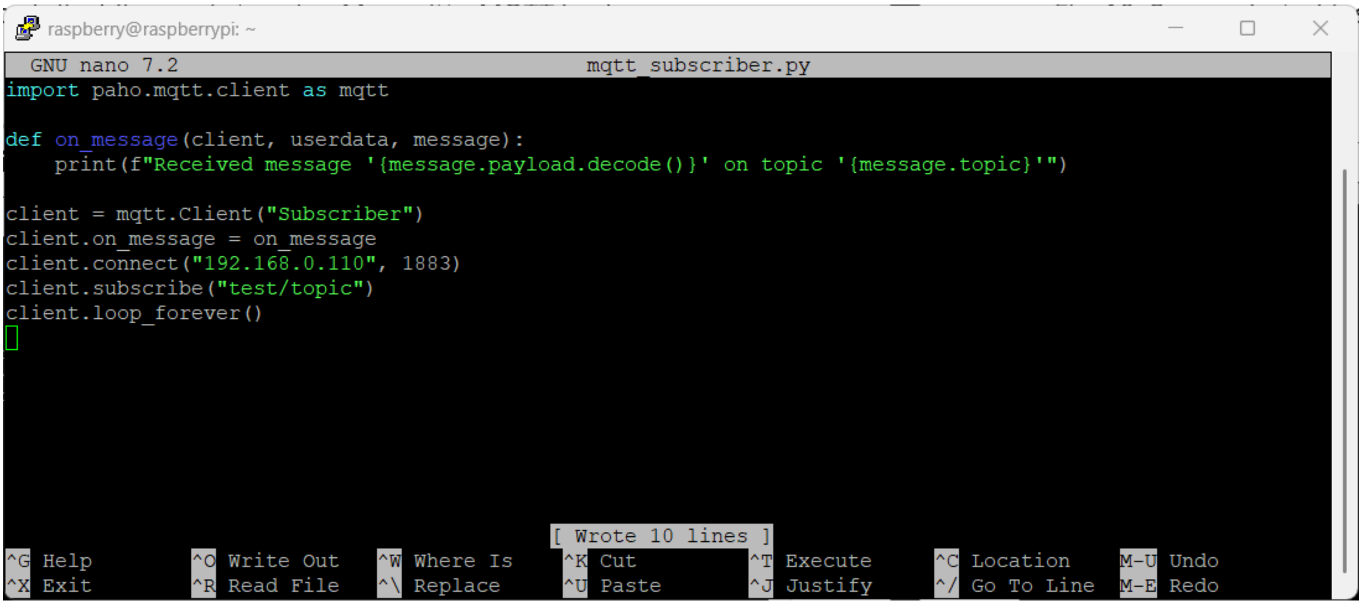


```
  GNU nano 7.2                                   mqtt_publisher.py
import paho.mqtt.client as mqtt
import time

client = mqtt.Client("Publisher")
client.connect("192.168.0.110", 1883)

while True:
    client.publish("test/topic", "Hello, MQTT!")
    time.sleep(5)








                                             [ Read 9 lines ]
^G Help          ^O Write Out     ^W Where Is      ^K Cut           ^T Execute       ^C Location      M-U Undo
^X Exit          ^R Read File     ^\ Replace       ^U Paste         ^J Justify       ^/ Go To Line    M-E Redo
```



```
  GNU nano 7.2                              mqtt_publisher.py
import paho.mqtt.client as mqtt
import time

# Define a callback for successful publishing
def on_publish(client, userdata, mid):
    print(f"Message {mid} published successfully!")

client = mqtt.Client(mqtt.CallbackAPIVersion.VERSION2)
client.on_publish = on_publish  # Attach the callback
client.connect("192.168.0.110", 1883)

while True:
    result = client.publish("test/topic", "Hello, MQTT!")
    result.wait_for_publish()  # Ensure the message is published before proceeding
    print("Published: Hello, MQTT!")
    time.sleep(5)

                                             [ Read 17 lines ]
^G Help         ^O Write Out    ^W Where Is     ^K Cut          ^T Execute      ^C Location     M-U Undo
^X Exit         ^R Read File    ^\ Replace      ^U Paste        ^J Justify      ^/ Go To Line   M-E Redo
```

Fig. 11. Screenshot of the Python Script for the MQTT Publisher `mqtt_publisher.py` with the address changed to the broker's IP address.

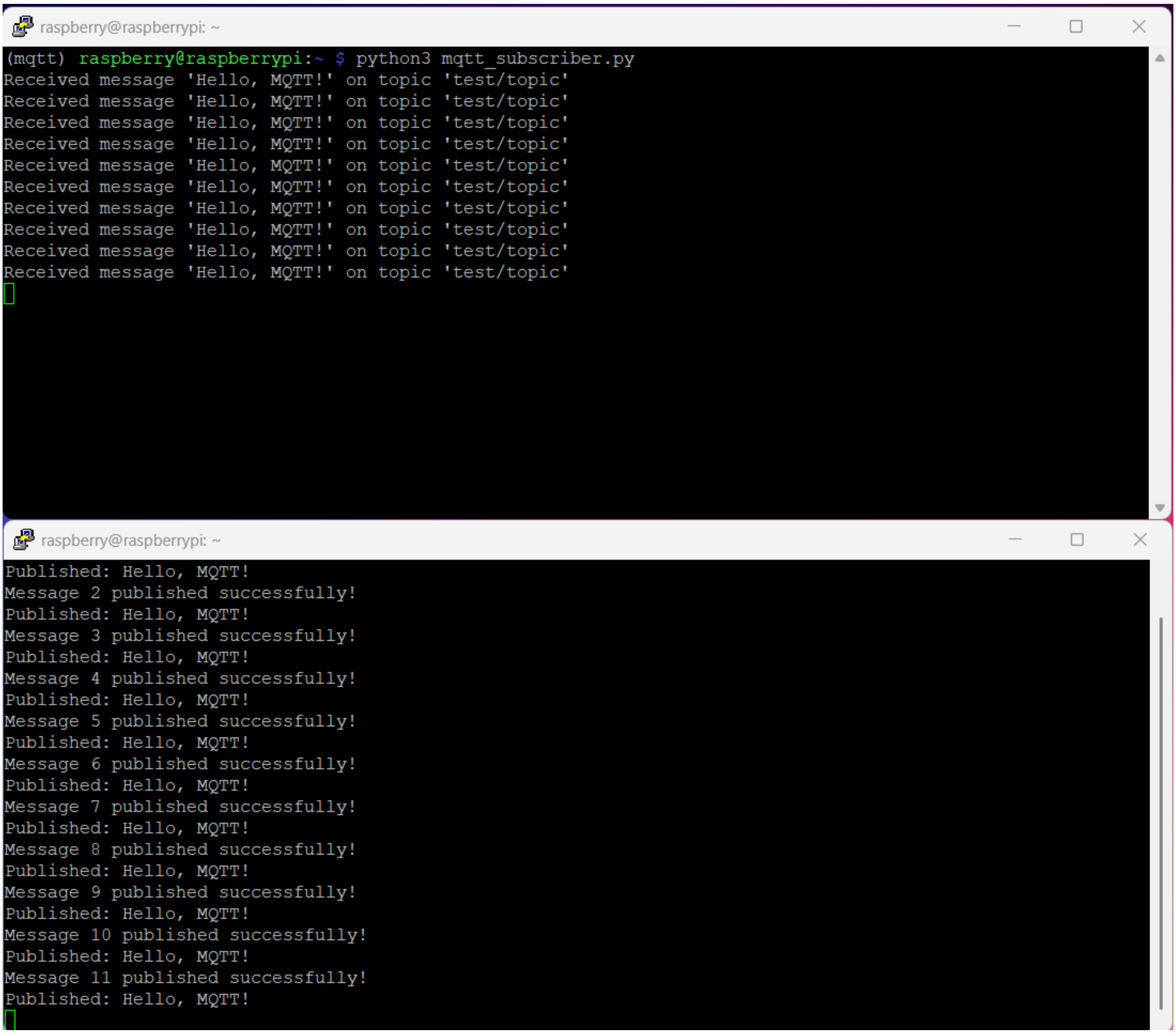


```
  GNU nano 7.2                              mqtt_subscriber.py
import paho.mqtt.client as mqtt

def on_message(client, userdata, message):
    print(f"Received message '{message.payload.decode()}' on topic '{message.topic}'")

client = mqtt.Client("Subscriber")
client.on_message = on_message
client.connect("192.168.0.110", 1883)
client.subscribe("test/topic")
client.loop_forever()


                                            [ Wrote 10 lines ]
^G Help         ^O Write Out    ^W Where Is     ^K Cut          ^T Execute      ^C Location     M-U Undo
^X Exit         ^R Read File    ^\ Replace      ^U Paste        ^J Justify      ^/ Go To Line   M-E Redo
```

Fig. 12. Screenshot of the Python Script for the MQTT Scriber `mqtt_subscriber.py` with the address changed to the broker's IP address.

4. Testing your MQTT Communication

Lab05 (MQTT) Screenshots



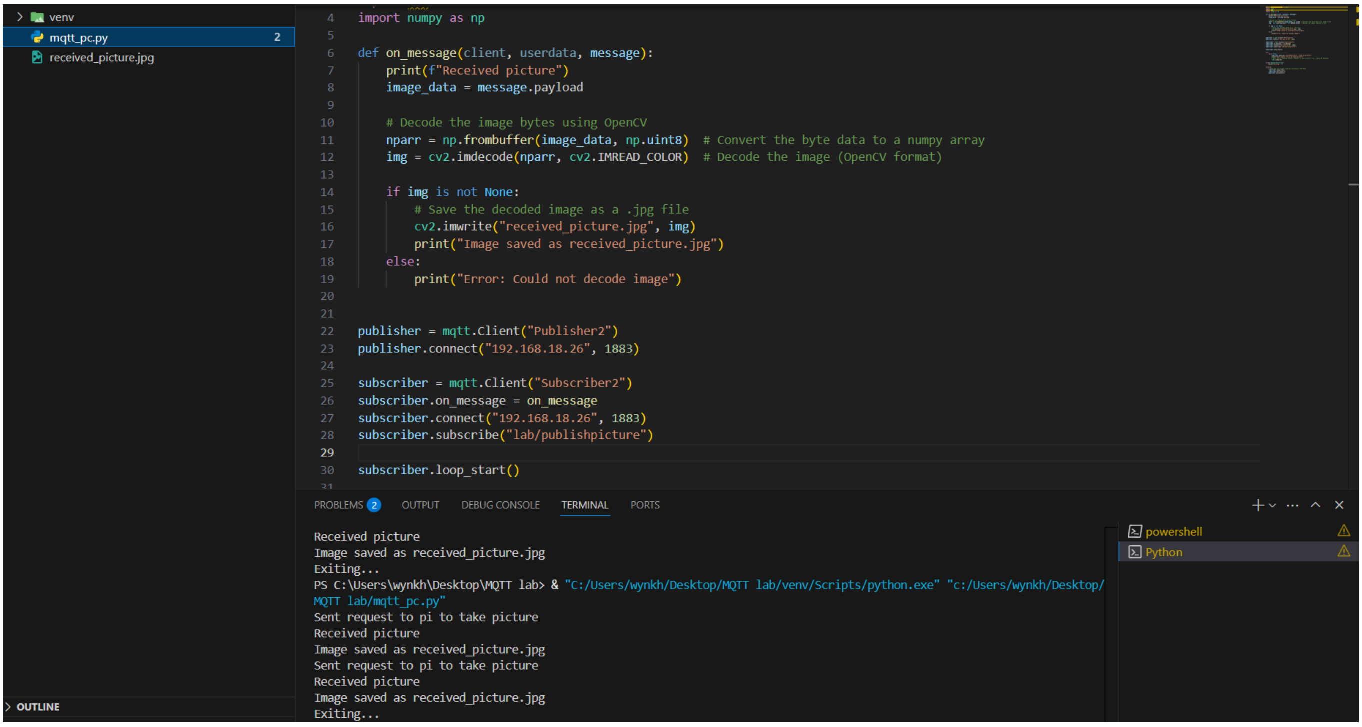
```
(mqtt) raspberry@raspberrypi:~ $ python3 mqtt_subscriber.py
Received message 'Hello, MQTT!' on topic 'test/topic'
Received message 'Hello, MQTT!' on topic 'test/topic'
Received message 'Hello, MQTT!' on topic 'test/topic'
Received message 'Hello, MQTT!' on topic 'test/topic'
Received message 'Hello, MQTT!' on topic 'test/topic'
Received message 'Hello, MQTT!' on topic 'test/topic'
Received message 'Hello, MQTT!' on topic 'test/topic'
Received message 'Hello, MQTT!' on topic 'test/topic'
Received message 'Hello, MQTT!' on topic 'test/topic'
Received message 'Hello, MQTT!' on topic 'test/topic'
```

```
Published: Hello, MQTT!
Message 2 published successfully!
Published: Hello, MQTT!
Message 3 published successfully!
Published: Hello, MQTT!
Message 4 published successfully!
Published: Hello, MQTT!
Message 5 published successfully!
Published: Hello, MQTT!
Message 6 published successfully!
Published: Hello, MQTT!
Message 7 published successfully!
Published: Hello, MQTT!
Message 8 published successfully!
Published: Hello, MQTT!
Message 9 published successfully!
Published: Hello, MQTT!
Message 10 published successfully!
Published: Hello, MQTT!
Message 11 published successfully!
Published: Hello, MQTT!
```

Fig. 13. Screenshot of the messages being published and received in each terminal

Lab05 (MQTT) Screenshots

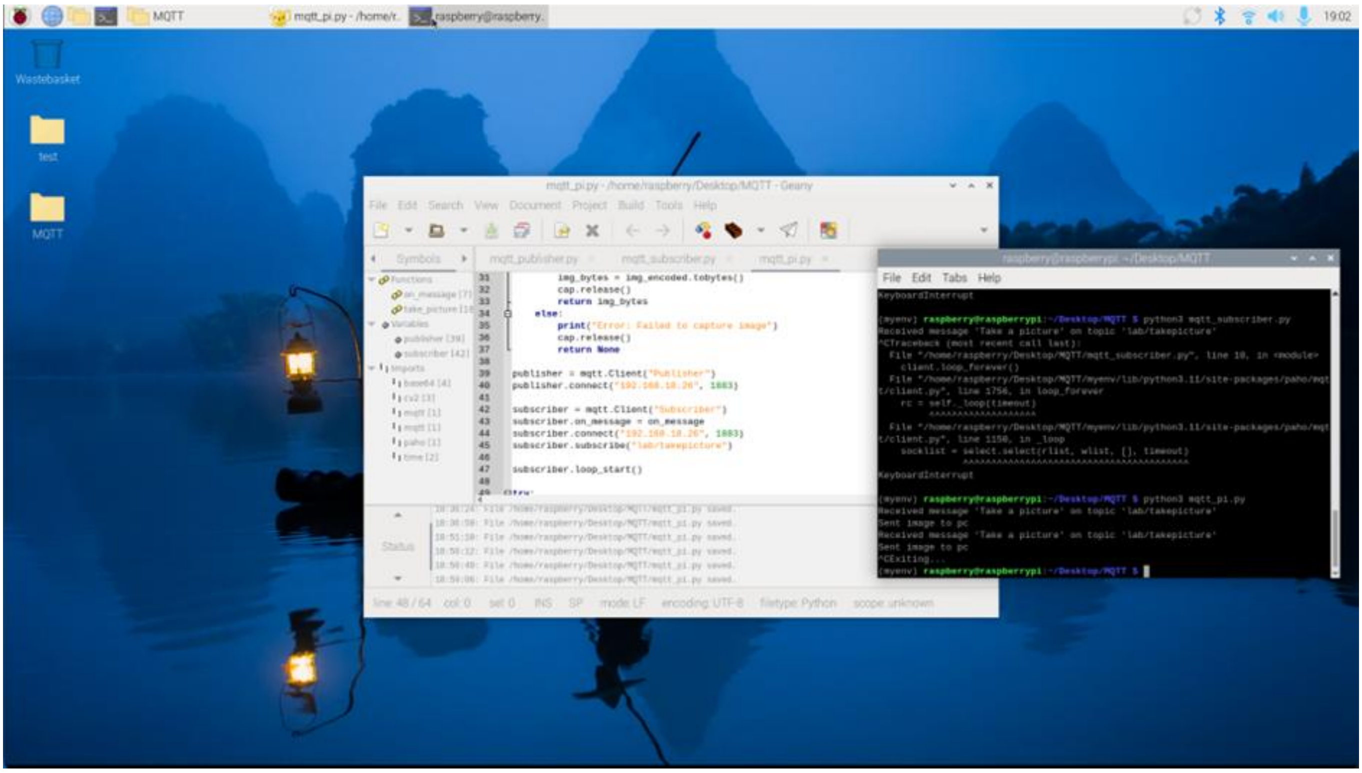
5. Lab Assignment (Did together with Wyvern Khiang 2200577)



```python
import numpy as np

def on_message(client, userdata, message):
    print(f"Received picture")
    image_data = message.payload

    # Decode the image bytes using OpenCV
    nparr = np.frombuffer(image_data, np.uint8)  # Convert the byte data to a numpy array
    img = cv2.imdecode(nparr, cv2.IMREAD_COLOR)  # Decode the image (OpenCV format)

    if img is not None:
        # Save the decoded image as a .jpg file
        cv2.imwrite("received_picture.jpg", img)
        print("Image saved as received_picture.jpg")
    else:
        print("Error: Could not decode image")


publisher = mqtt.Client("Publisher2")
publisher.connect("192.168.18.26", 1883)

subscriber = mqtt.Client("Subscriber2")
subscriber.on_message = on_message
subscriber.connect("192.168.18.26", 1883)
subscriber.subscribe("lab/publishpicture")

subscriber.loop_start()
```

```
Received picture
Image saved as received_picture.jpg
Exiting...
PS C:\Users\wynkh\Desktop\MQTT lab> & "C:/Users/wynkh/Desktop/MQTT lab/venv/Scripts/python.exe" "c:/Users/wynkh/Desktop/
MQTT lab/mqtt_pc.py"
Sent request to pi to take picture
Received picture
Image saved as received_picture.jpg
Sent request to pi to take picture
Received picture
Image saved as received_picture.jpg
Exiting...
```

Fig. 14. Screenshot of the code for MQTT



```python
            img_bytes = img_encoded.tobytes()
            cap.release()
            return img_bytes
        else:
            print("Error: Failed to capture image")
            cap.release()
            return None

publisher = mqtt.Client("Publisher")
publisher.connect("192.168.18.26", 1883)

subscriber = mqtt.Client("Subscriber")
subscriber.on_message = on_message
subscriber.connect("192.168.18.26", 1883)
subscriber.subscribe("lab/takepicture")

subscriber.loop_start()
```

```
18:36:24: File /home/raspberry/Desktop/MQTT/mqtt_pi.py saved.
18:36:56: File /home/raspberry/Desktop/MQTT/mqtt_pi.py saved.
18:51:58: File /home/raspberry/Desktop/MQTT/mqtt_pi.py saved.
18:58:12: File /home/raspberry/Desktop/MQTT/mqtt_pi.py saved.
18:58:40: File /home/raspberry/Desktop/MQTT/mqtt_pi.py saved.
18:59:06: File /home/raspberry/Desktop/MQTT/mqtt_pi.py saved.
```

```
KeyboardInterrupt

(myenv) raspberry@raspberrypi:~/Desktop/MQTT $ python3 mqtt_subscriber.py
Received message 'Take a picture' on topic 'lab/takepicture'
^CTraceback (most recent call last):
  File "/home/raspberry/Desktop/MQTT/mqtt_subscriber.py", line 10, in <module>
    client.loop_forever()
  File "/home/raspberry/Desktop/MQTT/myenv/lib/python3.11/site-packages/paho/mqt
t/client.py", line 1756, in loop_forever
    rc = self._loop(timeout)
         ^^^^^^^^^^^^^^^^^^^
  File "/home/raspberry/Desktop/MQTT/myenv/lib/python3.11/site-packages/paho/mqt
t/client.py", line 1150, in _loop
    socklist = select.select(rlist, wlist, [], timeout)
               ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
KeyboardInterrupt

(myenv) raspberry@raspberrypi:~/Desktop/MQTT $ python3 mqtt_pi.py
Received message 'Take a picture' on topic 'lab/takepicture'
Sent image to pc
Received message 'Take a picture' on topic 'lab/takepicture'
Sent image to pc
^CExiting...
(myenv) raspberry@raspberrypi:~/Desktop/MQTT $
```

Fig. 15. Screenshot of publisher taking webcam screenshot in the background and sending to the MQTT broker

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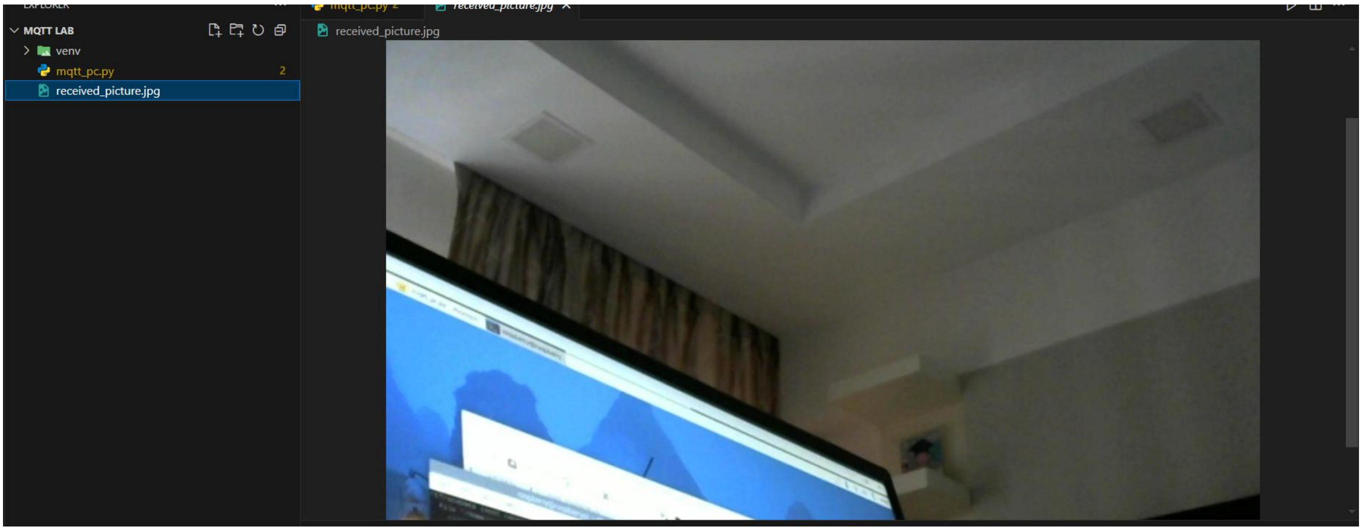

Fig. 15. Screenshot of image received by the subscriber from the MQTT broker