Turning On the Lights with Home Assistant and MQTT

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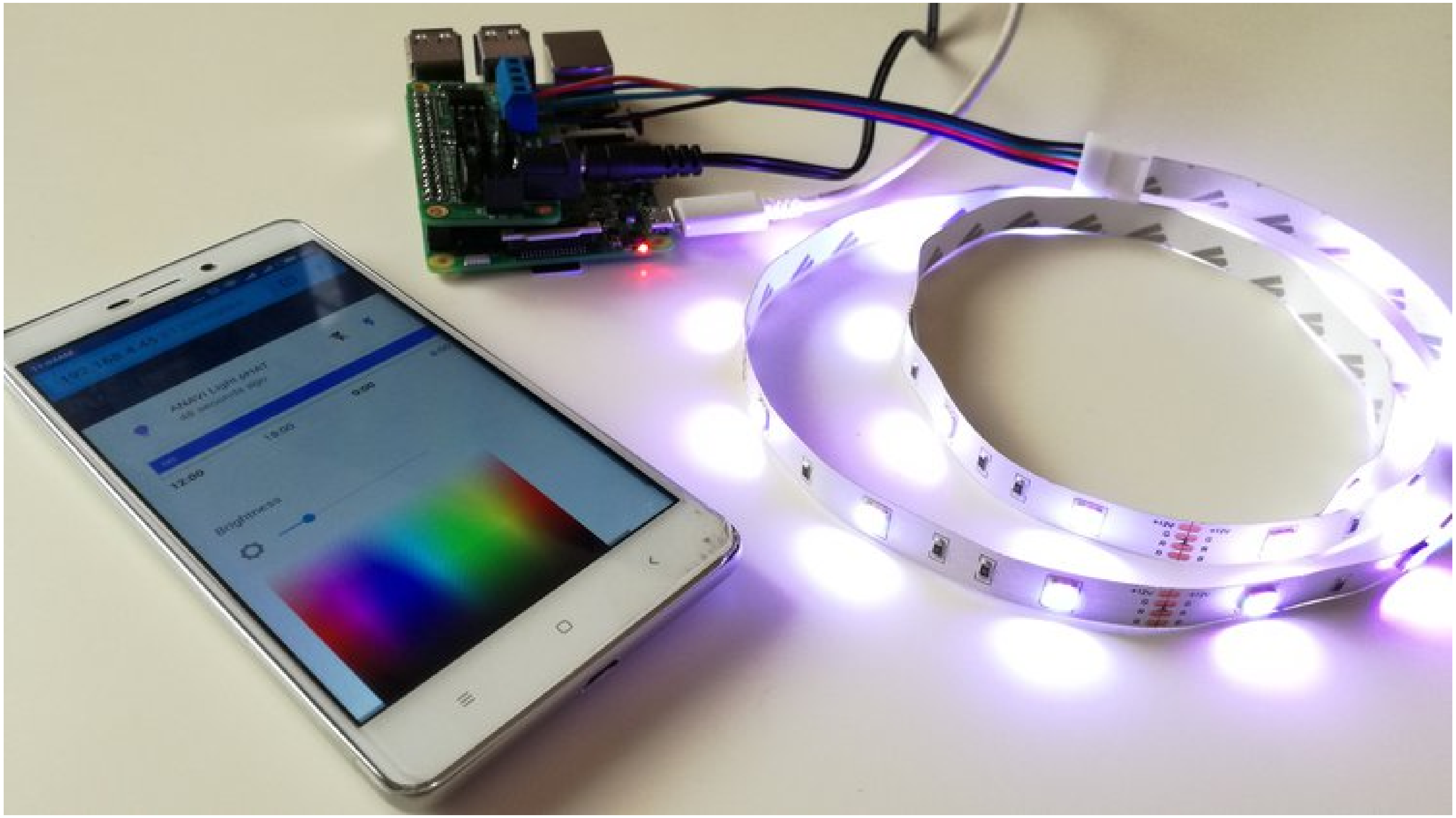
DEMO



Hardware

- Raspberry Pi 3 (or any other model and version
- ANAVI Light pHAT
- 12V 5050 RGB LED strip
- 12V power supply with 5.5*2.1mm DC jack
- 5V microUSB charger
- Amazon Echo Dot 2nd generation

ANAVI Light pHAT

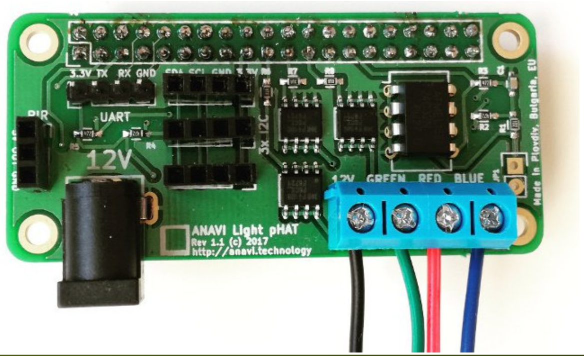
- Raspberry Pi add-on board for controlling 12V RGB LED strip
- Compatible with any model and verison of Raspberry Pi with 40 pin header
- Supports PIR motion sensor and up to 3 I2C sensor modules such as BH1750 for light, HTU21D for temperature and humidity, APDS-9960 for RGB color and gesture detection
- Open source hardware (CC BY-SA 4.0 license) designed with KiCAD EDA

  Schematics:

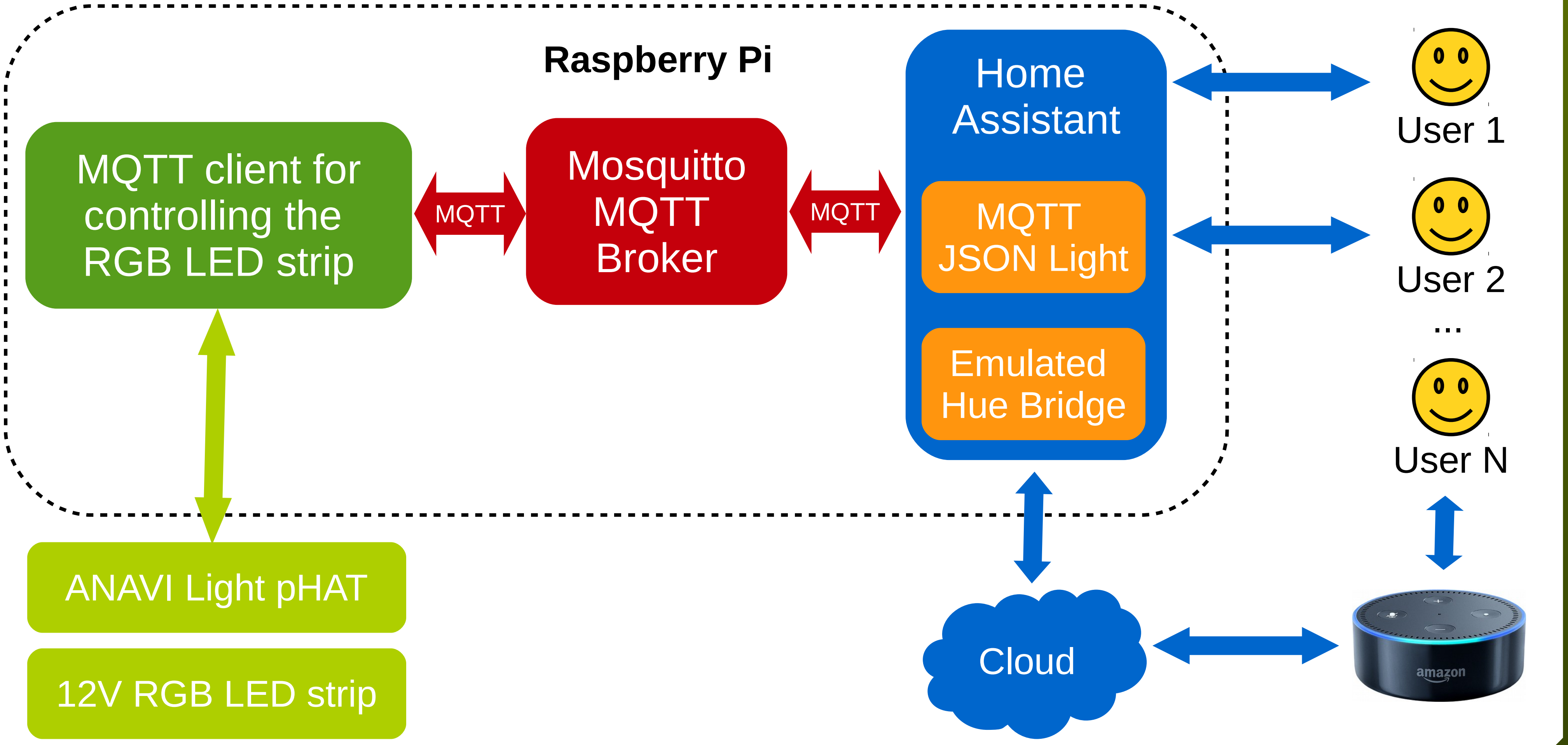
  https://github.com/AnaviTechnology/anavi-light

  Crowdfunding:

  https://www.crowdsupply.com/anavi-technology/light-phat



How Does it Work?



Home Assistant

- Open-source home automation platform running on Python 3
- Perfect to run on a Raspberry Pi
- More than 950 components for integration with popular Internet of Things such as IKEA Trådfri, Philips Hue, Google Assistant, Alexa / Amazon Echo, Nest, KODI, etc.
- Started in 2013 by Paulus Schoutsen
- Huge community, more than 830 contributors
- Source code available at GitHub under Apache 2.0 license
- https://home-assistant.io/

Home Assistant on Raspberry Pi

A couple of popular options for getting started:

- **Hass.io**

  An operating system based on ResinOS and Docker for running Home Assistant. Started by Pascal Vizeli in 2017. Compatible with Raspberry Pi, Intel NUC or generic Linux servers.

- **Hasspbian** (used for the demo)

  GNU/Linux distribution for Raspberry Pi with Home Assistant based on Raspbian that uses the same repositories.

MQTT

- Lightweight publish/subscribe machine-to-machine protocol on top of TCP/IP
- Near real-time communication
- Message broker
- Small source code footprint for embedded devices
- Open source MQTT brokers: Mosquitto, HiveMQ, Mosca, emqttd, etc.

- http://mqtt.org/

Mosquitto

- Open source MQTT broker implemented in the C programming language
- Supports MQTT protocol version 3.1 and 3.1.1
- Supports web sockets
- Available for all popular GNU/Linux distributions, Windows, FreeBSD and Mac
- Project of iot.eclipse.com
- https://mosquitto.org/

Installing Mosquitto on Hassbian

- Script **hassbian-config** simplifies the installation of the latest version of the Mosquitto package from the official repository:

```
sudo hassbian-config install mosquitto
```

- Configure client authentication in Mosquitto using a username and password (optional but highly recommended)
- Set the MQTT broker in **configuration.yaml** for Home Assistant

```
mqtt:
  discovery: true
  broker: hassbian.local
  port: 1883
```

anavid

- Open source Linux daemon application written C for managing ANAVI Light pHAT on Raspberry Pi through MQTT
- Supports the format of MQTT JSON Light component of Home Assistant
- Uses **Paho MQTT C** library for implementation of MQTT client
- Uses **PiGPIO** library for PWM control of the RGB LED strip
- Uses **WiringPi** library for retrieving data from the supported I2C sensor modules
- Available at GitHub under GNU General Public License v3.0:

  https://github.com/AnaviTechnology/anavid

Installing anavid

- Building from source

```
git clone https://github.com/AnaviTechnology/anavid.git
cd anavid
make
sudo make install
```

- Using deb package (created with debuild)

```
sudo dpkg -i anavi_0.0.1_armhf.deb
```

- Configurations stored at **/etc/anavilight.ini**

Ecplise Paho Project

- Provides open-source client implementations of MQTT and MQTT-SN messaging protocols
- Supports various programming language: C, C++, Java, JavaScript, Python, Go, Rust, C#
- Project of the Eclipse Foundation
- Anavid uses Paho MQTT C client for Posix and Windows:

```
MQTTClient_create(&client, config.address, config.clientId,
        MQTTCLIENT_PERSISTENCE_NONE, NULL);
```

```
MQTTClient_setCallbacks(client, NULL, connlost, msgarrvd, delivered);
```

```
MQTTClient_publishMessage(client, mqttTopic, &pubmsg, &token);
```

The piGPIO Library

- Written in the C programming language
- The pigpio daemon offers a socket and pipe interface to the underlying C library
- Source code at GitHub: https://github.com/joan2937/pigpio
- Used by **anavid** for controlling the color of the RGB LED strip through software PWM:

```
cmdCmd_t cmd;
cmd.cmd = PI_CMD_PWM;
cmd.p1 = pin;
cmd.p2 = value;
cmd.p3 = 0;
```

```
send(sock, &cmd, sizeof(cmdCmd_t), 0)

…

recv(sock, &cmd, sizeof(cmdCmd_t), MSG_WAITALL)
```

Systemd

- Init system in Linux distributions
- Runs as PID 1 and starts the rest of the system
- anavi systemd service:

```
[Unit]
Description=ANAVI Daemon Service
After=pigpio.service
Requires=pigpio.service

[Service]
Type=simple
ExecStart=/usr/local/bin/anavid
Restart=on-failure
RestartSec=10

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

Managing anavi.service

- Enable systemd service at launch of Raspberry Pi:

```
sudo systemctl enable anavi
```

- Start the systemd service:

```
sudo systemctl start anavi
```

- Stop the systemd service:

```
sudo systemctl stop anavi
```

- Check the status of the service:

```
sudo systemctl status -l anavi
```

- See all log messages:

```
sudo journalctl -u anavi
```

machine ID

- Unique machine ID of the local system that is initialized by systemd-machine-id-setup during installation or boot
- Stored at at single newline-terminated, hexadecimal, 32-character, lowercase text at **/etc/machine-id**
- Used by anavid in MQTT topics to identify different devices *(due to security issues I am considering to keep it private via cryptographic hash function)*
- More details at:

  https://www.freedesktop.org/software/systemd/man/machine-id.html

MQTT JSON Light Component

- Home Assistant component for controlling a MQTT-enabled light that can receive JSON messages

  https://home-assistant.io/components/light.mqtt_json/

- Example configuration for ANAVI Light pHAT, where *YOURMACHINEID* should match **/etc/machine-id**:

```
light:
  - platform: mqtt_json
    name: "ANAVI Light pHAT"
    command_topic: "YOURMACHINEID/action/rgbled"
    brightness: true
    rgb: true
```

MQTT JSON Light Messages

- MQTT topic:

```
YOURMACHINEID/action/rgbled
```

- Setting brightness in range from 0 to 255:

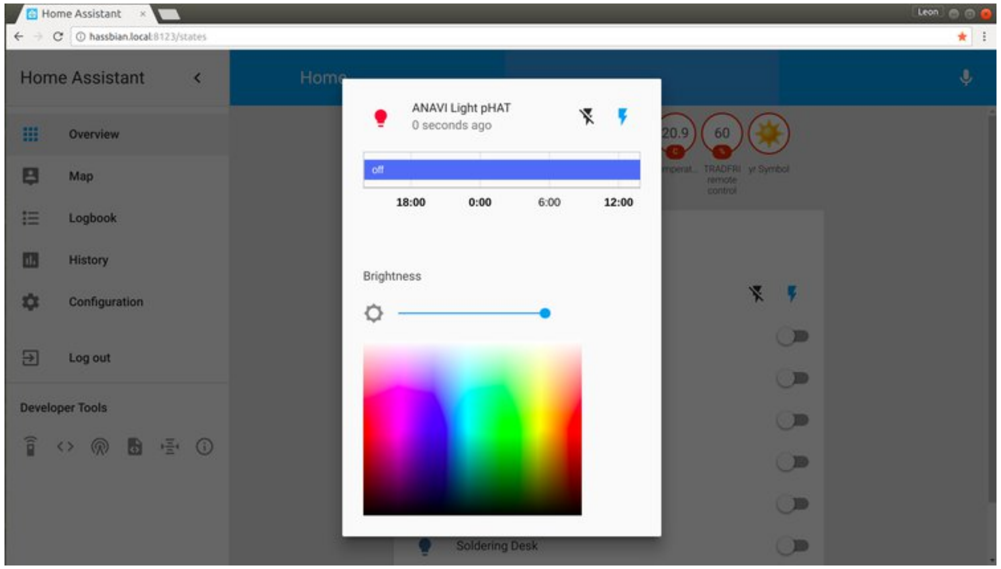
```
{
      "brightness": 255
}
```

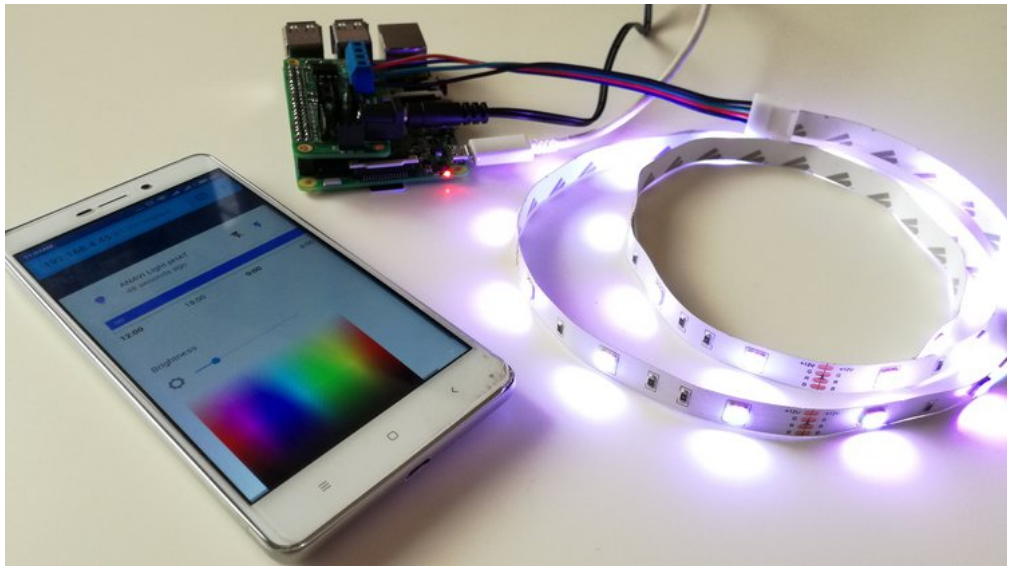
- Setting specific color in RGB color model in range from 0 to 255 for each LED, for example pink:

```
{
      "red": 255,
      "green": 20,
      "blue": 147
}
```

Home Assistant UI

- User friendly and responsive web interface that can be accesses from any modern web browser on smartphone, tablet or a personal computer





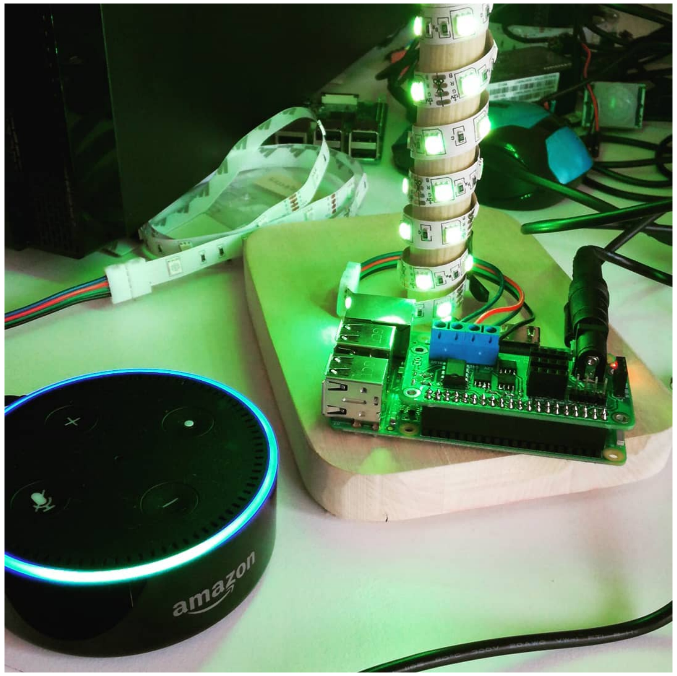
Simple Voice Control with Alexa

- Home assistant is compatible with Alexa and Amazon Echo
- Basic integration using the Emalutated Hue Bridge component of Home Assistant
- Emalutated Hue Bridge allows non-Philips Hue devices to be controlled though with voice the built-in support of Amazon Echo

```
emulated_hue:
  type: alexa
  expose_by_default: true
```

Simple Voice Control with Alexa

- Example voice commands for MQTT JSON Light component configured with name “ANAVI Light pHAT” in **configuration.yaml**:

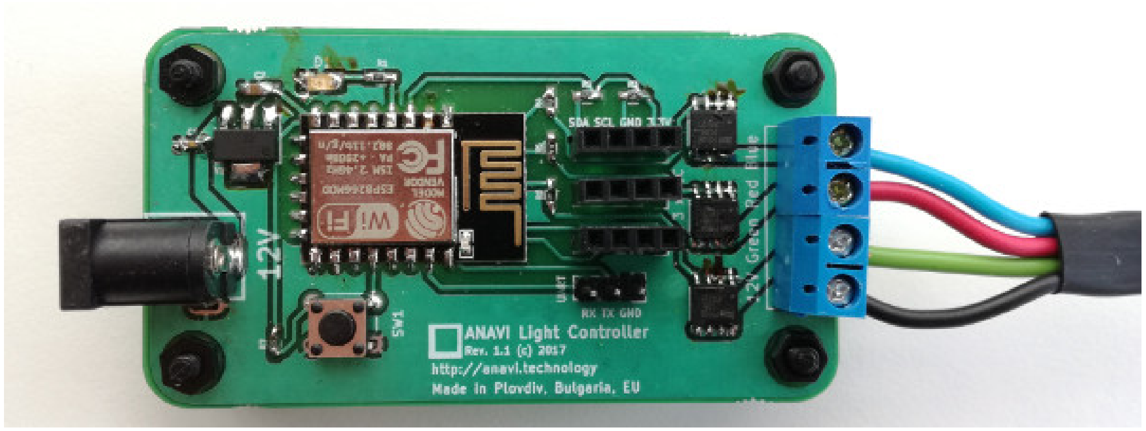


Alexa, turn **ON** ANAVI Light pHAT

Alexa, turn **OFF** ANAVI Light pHAT

ANAVI Light Controller

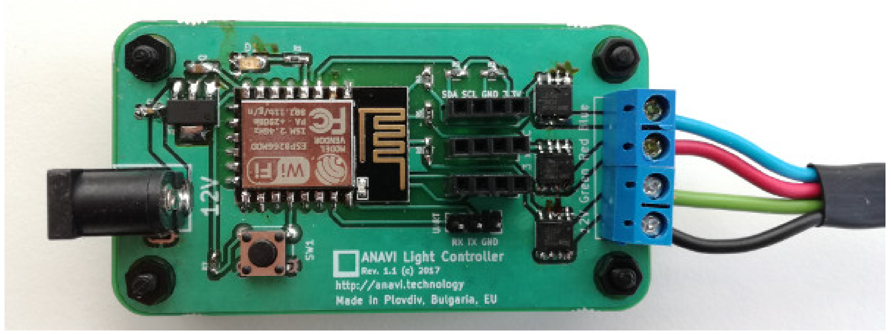
- Low cost alternative as a standalone embedded device for controlling 12V RGB LED strip with **ESP8266** WiFi microcontroller (work in progress)
- Open source hardware designed in KiCAD EDA and software powered by ESP8266 core for Arduino



https://github.com/AnaviTechnology/anavi-light-controller

Software for ANAVI Light Controller

- Flashing through UART to USB debug cable and by holding the button connected to GPIO0 at boot time
- Relies on ESP8266 core for Arduino and depends on the libraries **WiFiManager**, **PubSubClient** and **ArduinoJson**
- Gets chip ID as a 32-bit integer from the ESP-specific API **ESP.getChipId()**
- Software defined PWN using **analogWrite()** with default frequency of 1kHz



Comparison

	ANAVI Light pHAT	ANAVI Light Controller
12V RGB LED	Yes	Yes
WiFi	Yes (through Raspberry Pi)	Yes
Open Source Hardware	Yes	Yes
Slots for I2C sensors	3	3
PIR motion sensor	Yes	No
Stand-alone	**No** (requires Raspberry Pi with 40 pin header)	**Yes** (with built-in ESP8266 module)
Power Supply	**12V 5.5*2.1 DC jack + 5V microUSB** for Raspberry Pi	12V 5.5*2.1 DC jack

Conclusions

- The integration of new embedded devices through the MQTT JSON Light component in Home Assistant is straight-forward
- Further efforts are needed to make the proposed open source solution for smart lightning more secure, user-friendly and easier to setup for non-technical users
- Using microcontrollers with WiFi, like ESP8266, significantly reduces the cost of the smart lightning
- Combining open source hardware with free and open source software brings value to the community as it allows anyone to study, modify, make and improve the design

Thank You!

Useful links:

- https://home-assistant.io/
- http://mqtt.org/
- https://mosquitto.org/
- https://www.eclipse.org/paho/
- https://www.linux.com/news/home-assistant-python-approach-home-automation-video
- http://abyz.me.uk/rpi/pigpio/
- http://esp8266.github.io/Arduino/
- https://github.com/AnaviTechnology/
- https://www.crowdsupply.com/anavi-technology/light-phat