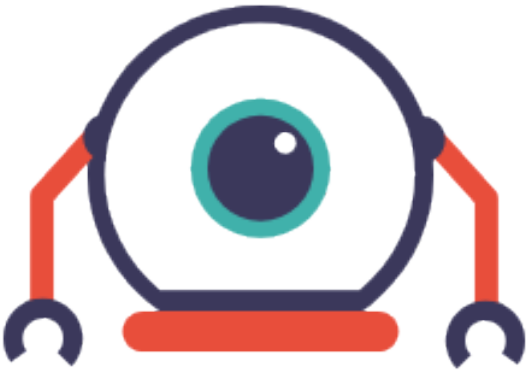


TERMITE OS

THE TELESCOPE OPERATING SYSTEM

termiteOS Documentation

Release alpha

Nacho Mas

July 30, 2018

1 Introduction 3

2 Architecture 5

3 License 7

4 Technical information 9

Index 25

A telescope Operating System base on zmq and Protocol Buffers. Documentation https://nachoplus.github.io/termiteOS/index.html

CHAPTER

ONE

INTRODUCTION

Termite OS is a modular, adaptable, easily extendable telescope operating system developed primarily, but not exclusively, in python.

It wants to answer to several limitations that most of the commercial mount controllers have. It wants to be a platform where you can incorporate all kinds of functionalities that the professional or amateur astronomer may need in a simple way.

Posible use case:

- To motorize a DIY mount or retrofit a old one.
- Make your telescope be able to track the ISS or any other satellite.
- Implement new protocol commands.
- New native protocols, i.e. indilib
- Control over the objects catalogs built into your telescope.
- Integrate pointing model in your mount.
- Connect a GPS to your mount and use his data for location and time.
- Define the horizon of your observatory.
- WiFi or Bluetooth access to your mount
- Develope new motion estrategies.

With termiteOS you will address all this things and more.

Termite OS is a **work in progress** but much of the functionality is already available:

- Stepper controller using Raspberry PI and the integrated DRV8825 widely used in the 3D printer world
- LX200 command set
- Slew and celestial track
- Satellite tracking

Ongoing funtionality:

- Arduino base hardware
- BLDC motors
- Servo motors
- Web interface
- Constellation pointing

CHAPTER

TWO

ARCHITECTURE

Each termiteOS functionality is implemented as a separate program called a'node'. The nodes communicate each other using the zmq protocol. The organization between the nodes is hierarchical thus a node can have several children but has only one parent or none in the case of the'root node'.

ZMQ (http://zeromq.org/) is used for transport and on https://developers.google.com/protocol-buffers/ for message definitions and serialization.

Each node has its own ZMQ port and a set of commands and responds to through that port. Each node opens connections with its parent node and with all its children so that messages can be exchanged.

These nodes can run on the same or different CPUs taking advantage of all the features of the ZMQ protocol.

CHAPTER

THREE

LICENSE

Logo made with https://www.designevo.com/en/ DesignEvo

CHAPTER

FOUR

TECHNICAL INFORMATION

Launcher

- **Launcher** program launch a set of node following the instruction in yaml file

This program allow to launch at once all nodes needed for a specific hardware/funtionality.

Example of a yaml configuration file:

```
simple:
 type: telescope
 host: localhost
 port: 5000
 nodes:
    - LX200:
        type: tcpproxy
        host: localhost
        port: 5001
        params: {'tcpport':6001,'End':'#'}
    - tracker:
        type: TLEtracker
        host: localhost
        port: 5002
        nodes:
           - trackertcp:
                type: tcpproxy
                host: localhost
                port: 5003
                params: {'tcpport':6003}
```

This example is equivalent to run on the command shell all following commands:

```
miteTelescope   --port 5000 --name simple
mitetcpproxy    --port 5001 --name LX200 --parent_host localhost --parent_port 5000 --params {'tcp
miteTLEtracker  --port 5002 --name tracker --parent_host localhost --parent_port 5000
mitetcpproxy    --port 5003 --name trackertcp --parent_host localhost --parent_port 5002 --params
```

You can find other examples in 'termoteOS/machines/'

Command line:

miteLaunch

Launch all nodes defined in YAMLFILE

```
miteLaunch [OPTIONS] YAMLFILE
```

Arguments

YAMLFILE
Required argument

API

Launch tools to run a rig. Run several daemons at once

termiteOS.launch.**launchmachine**(*yamlfile*)
Launch an arragement of daemons defined in a yaml file

termiteOS.launch.**launchnode**(*nodedict*, *parent_host=''*, *parent_port=False*)
Launch a node defined in dictionary. Called recursively

termiteOS.launch.**run_in_separate_process**(*func*, **args*, ***kwds*)
Run function in a separate process. To background executables

Nodes

Nodes are separate programs. The nodes communicate each other using the zmq protocol. The organization between the nodes is hierarchical thus a node can have several children but has only one parent or none in the case of the'root node'.

Nodes are based on http://zeromq.org/ for transport and on https://developers.google.com/protocol-buffers/ for message definitions and serialization.

Each node has its own ZMQ port and a set of commands and responds to through that port. Each node opens connections with its parent node and with all its children so that messages can be exchanged.

These nodes can run on the same or different CPUs taking advantage of all the features of the ZMQ protocol.

All nodes are derive from nodeSkull base class which implements all the comunication logic and basic commands.

TLEtracker

- **TLEtracker** node calculate satellite TLE speed and RA/DEC and send to the mount

With this node the mount is able to follow any object with TLE.

Command line:

miteTLEtracker

Launch a TLEtracker node

```
miteTLEtracker [OPTIONS]
```

Options

--name <name>
module name

--port <port>
Port listen

--parent_host <parent_host>
Parent host to connect to. If False the node become a ROOTHUB

--parent_port <parent_port>
Parent port to connect to

TLEtracker commands

nodes

list the children nodes:

param arg (None)

returns a python list all children node names

follow

Follow satellite

ping

None

tree

Print all self and children nodes availabled commands

param arg (None)

returns a string contain all commands

help

Print help text. Do nothing. Normaly overloaded by a child class

ls

list the node commands

hub

- **hub** node has not own commands. Only used to connect other nodes

Command line:

miteHub

Launch a hub node

```
miteHub [OPTIONS]
```

Options

--name <name>
module name

--port <port>
Port listen

--parent_host <parent_host>
Parent host to connect to. If False the node become a ROOTHUB

--parent_port <parent_port>
Parent port to connect to

hub commands

nodes

list the children nodes:

param arg (None)

returns a python list all children node names

ping

None

tree

Print all self and children nodes availabled commands

param arg (None)

returns a string contain all commands

help

Print help text. Do nothing. Normaly overloaded by a child class

ls

list the node commands

joystick

- **joystick** node to manual move the mount with a joystick

Command line:

miteJoy

Launch a joystick node

```
miteJoy [OPTIONS]
```

Options

--name <name>
module name

--port <port>
Port listen

--parent_host <parent_host>
Parent host to connect to. If False the node become a ROOTHUB

--parent_port <parent_port>
Parent port to connect to

joystick commands

nodes

list the children nodes:

param arg (None)

returns a python list all children node names

ping

None

tree

Print all self and children nodes availabled commands

param arg (None)

returns a string contain all commands

help

Print help text. Do nothing. Normaly overloaded by a child class

ls

list the node commands

tcpproxy

- **tcproxy** node acts as a proxy connector between other node and an especific TCP port

All commands recived throught the TCP port are relay to the myCmdPort port of the node conected to.

Using this node allow us to connect to a specific node (the parent node of tcpproxy node) with a regular *telnet host port*

Command line:

mitetcpproxy

Launch a tcpproxy node

```
mitetcpproxy [OPTIONS]
```

Options

--name <name>
module name

--port <port>
Port listen

--parent_host <parent_host>
Parent host to connect to. If False the node become a ROOTHUB

--parent_port <parent_port>
Parent port to connect to

--params <params>
Dictionary with extra parameters default={"tcpport":6001,"End":"#"}

tcpproxy commands

nodes

list the children nodes:

param arg (None)

returns a python list all children node names

ping

None

tree

Print all self and children nodes availabled commands

param arg (None)

returns a string contain all commands

help

Print help text. Do nothing. Normaly overloaded by a child class

ls

list the node commands

Telescope

- **telescope** node implement a telescope mount basic commands (goto,slew,track..)

Two axis equatorial mount telescope.

Command line:

miteTelescope

Launch a telescope node

```
miteTelescope [OPTIONS]
```

Options

--name <name>
module name

--port <port>
Port listen

--parent_host <parent_host>
Parent host to connect to. If False the node become a ROOTHUB

--parent_port <parent_port>
Parent port to connect to

telescope commands

getTargetRA

None

nodes

list the children nodes:

param arg (None)

returns a python list all children node names

getLocalDate

None

getTelescopeDEC

None

stopSlew

None

ack

None

slewRate

None

ping

None

info

None

getSideralTime

None

setTargetRA

None

getLocalTime

None

firware_date

None

setTargetDEC

None

tree

Print all self and children nodes availabled commands

param arg (None)

returns a string contain all commands

setMaxSlewRate

None

help

Print help text. Do nothing. Normaly overloaded by a child class

firware_ver

None

getTargetDEC

None

pulseE

None

slew

None

pulseN

None

pulseW

None

getTelescopeRA

None

pulseS

None

ls

list the node commands

align2target

None

Node commands

TLEtracker commands

nodes

list the children nodes:

param arg (None)

returns a python list all children node names

follow

Follow satellite

ping

None

tree

Print all self and children nodes availabled commands

param arg (None)

returns a string contain all commands

help

Print help text. Do nothing. Normaly overloaded by a child class

ls

list the node commands

costellation commands

help

Print help text. Do nothing. Normaly overloaded by a child class

nodes

list the children nodes:

param arg (None)

returns a python list all children node names

follow

None

ping

None

tree

Print all self and children nodes availabled commands

param arg (None)

returns a string contain all commands

ls

list the node commands

hub commands

nodes

list the children nodes:

param arg (None)

returns a python list all children node names

ping

None

tree

Print all self and children nodes availabled commands

param arg (None)

returns a string contain all commands

help

Print help text. Do nothing. Normaly overloaded by a child class

ls

list the node commands

joystick commands

nodes

list the children nodes:

param arg (None)

returns a python list all children node names

ping

None

tree

Print all self and children nodes availabled commands

param arg (None)

returns a string contain all commands

help

Print help text. Do nothing. Normaly overloaded by a child class

ls

list the node commands

tcpproxy commands

nodes

list the children nodes:

param arg (None)

returns a python list all children node names

ping

None

tree

Print all self and children nodes availabled commands

param arg (None)

returns a string contain all commands

help

Print help text. Do nothing. Normaly overloaded by a child class

ls

list the node commands

telescope commands

getTargetRA

None

nodes

list the children nodes:

param arg (None)

returns a python list all children node names

getLocalDate

None

getTelescopeDEC

None

stopSlew

None

ack

None

slewRate

None

ping

None

info

None

getSideralTime

None

setTargetRA

None

getLocalTime

None

firware_date

None

setTargetDEC

None

tree

Print all self and children nodes availabled commands

param arg (None)

returns a string contain all commands

setMaxSlewRate

None

help

Print help text. Do nothing. Normaly overloaded by a child class

firware_ver

None

getTargetDEC

None

pulseE

None

slew

None

pulseN

None

pulseW

None

getTelescopeRA

None

pulseS

None

ls

list the node commands

align2target

None

Drivers

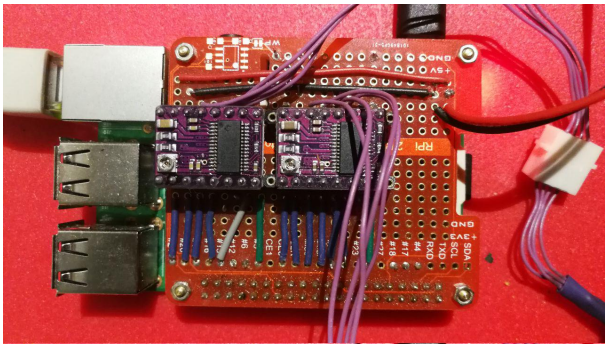
Drivers interact with the real hardware and normaly are used in the **node** code.

Motors

Raspberry Drivers

rpiDRV8825Hat

This is a DIY Raspberry Pi Hat base on the popular stepper control chip DRV8825



API DIY DRV8825 driver Hat interface.

This board has two DRV8825 able to driver 2 motors See hardware on termiteOS/driver/rpi/hardware

INTERFACE TO OTHER MODULES:

- motorBeta
- pinout
- microsteps
- clutch()
- reset()
- sleep()
- set_microsteps(microsteps)
- sync(motorBeta)

class `termiteOS.drivers.rpi.rpiDRV8825Hat.`**`rpiDRV8825Hat`**(*raspberry*, *driverID*, ***kwds*)

This class define the PIN mapping and basic methods for the rpiDVR8825 Hat

---

Note: Posible values of driverID can be 0 or 1.

`clutch`(*ON_OFF*)

Engage or Disengage(free spinnig) the motors

`fault`(*gpio*, *level*, *tick*)

Callback function to check internal driver faults

reset(*ON_OFF*)
Reset the driver circuit

set_dir(*dir*)
Set the direction of motion

set_microsteps(*microsteps*)
Set microstepping mode of the driver

sleep(*ON_OFF*)
Sleep or wake up the driver circuit

stepcounter(*gpio*, *level*, *tick*)
Callback function to update internal position counter

sync(*position*)
Set the actual internal position == position

test()
Test the Hat sending steps

rpiSpeedPWM

A PWM driver

API Raspberry PWM motor driver.

INTERFACE:

- **inherits several methods from rpiDRV8825Hut base class**
  - betaMotor
  - pinout
  - microsteps
  - clutch()
  - reset()
  - sleep()
  - set_microsteps(microsteps)
  - sync(position)
- **Own methods:**
  - setSpeed (radians/seconds)
  - setRPM(RPM)
  - SetPoint(setpoint)
  - goto() -> absolute SetPoint
  - move() -> relative SetPoint
  - stop()
  - isStopped
  - gotoEnd
  - pos

class termiteOS.drivers.rpi.rpiSpeedPWM.**rpiSpeedPWM**(*driverID*, *microsteps*, *FullTurnSteps*, *gear=1*, *name='Axis'*, *raspberry='localhost'*)

This class do the PWM control calling the underlying pigpiod daemon.

Note: Up to dates only PID control is implemented.

SetPoint(*setpoint*)
Establish the _SetPoint value

clutch(*ON_OFF*)
Engage or Disengage(free spinnig) the motors

fault(*gpio*, *level*, *tick*)
Callback function to check internal driver faults

goto(*setpoint*, *blocking=False*)
Absolute movement

gotoEnd
True if the axis finally arrive to destination(_SetPoint), False otherwise

isStopped
True if is stopped, False otherwise

move(*relsetpoint*)
Relative movement

pos
Actual position (Corrected motorBeta)

rampUp(*v*, *deltaT*, *out_min=-750*, *out_max=750*)
Limit motor speed changes to avoid axis stalling

reset(*ON_OFF*)
Reset the driver circuit

run(**args*, ***kwargs*)

setRPM(*rpm*)
Set and start PWM to obtain rpm

setSpeed(*v*)
Set and start PWM to obtain radians/seconds

set_dir(*dir*)
Set the direction of motion

set_microsteps(*microsteps*)
Set microstepping mode of the driver

sleep(*ON_OFF*)
Sleep or wake up the driver circuit

stepcounter(*gpio*, *level*, *tick*)
Callback function to update internal position counter

stop()
Not implemented

stopPWM()
Stop PWM generation without any check

sync(*newposition*)
Establish newposition as current possition (motorBeta)

test()
Test the Hat sending steps

trackSpeed(*trackSpeed*)
Set axis track speed. Track speed*timestep is add to the _SetPoint value

termiteOS.drivers.rpi.rpiSpeedPWM.**threaded**(*fn*)
Multithread wrapper. Used as a function decorator

Miscellaneus

TBD

Indices and tables

- genindex
- modindex
- search

Symbols

–name <name>
    miteHub command line option, 11
    miteJoy command line option, 12
    mitetcpproxy command line option, 13
    miteTelescope command line option, 14
    miteTLEtracker command line option, 10
–params <params>
    mitetcpproxy command line option, 13
–parent_host <parent_host>
    miteHub command line option, 11
    miteJoy command line option, 12
    mitetcpproxy command line option, 13
    miteTelescope command line option, 14
    miteTLEtracker command line option, 10
–parent_port <parent_port>
    miteHub command line option, 11
    miteJoy command line option, 12
    mitetcpproxy command line option, 13
    miteTelescope command line option, 14
    miteTLEtracker command line option, 10
–port <port>
    miteHub command line option, 11
    miteJoy command line option, 12
    mitetcpproxy command line option, 13
    miteTelescope command line option, 14
    miteTLEtracker command line option, 10

C

clutch() (termiteOS.drivers.rpi.rpiDRV8825Hat.rpiDRV8825Hat method), 20
clutch() (termiteOS.drivers.rpi.rpiSpeedPWM.rpiSpeedPWM method), 22

F

fault() (termiteOS.drivers.rpi.rpiDRV8825Hat.rpiDRV8825Hat method), 20
fault() (termiteOS.drivers.rpi.rpiSpeedPWM.rpiSpeedPWM method), 22

G

goto() (termiteOS.drivers.rpi.rpiSpeedPWM.rpiSpeedPWM method), 22
gotoEnd (termiteOS.drivers.rpi.rpiSpeedPWM.rpiSpeedPWM attribute), 22

I

isStopped (termiteOS.drivers.rpi.rpiSpeedPWM.rpiSpeedPWM attribute), 22

L

launchmachine() (in module termiteOS.launch), 10
launchnode() (in module termiteOS.launch), 10

M

miteHub command line option
    –name <name>, 11
    –parent_host <parent_host>, 11
    –parent_port <parent_port>, 11
    –port <port>, 11
miteJoy command line option
    –name <name>, 12
    –parent_host <parent_host>, 12
    –parent_port <parent_port>, 12
    –port <port>, 12
miteLaunch command line option
    YAMLFILE, 10
mitetcpproxy command line option
    –name <name>, 13
    –params <params>, 13
    –parent_host <parent_host>, 13
    –parent_port <parent_port>, 13
    –port <port>, 13
miteTelescope command line option
    –name <name>, 14
    –parent_host <parent_host>, 14
    –parent_port <parent_port>, 14
    –port <port>, 14
miteTLEtracker command line option
    –name <name>, 10
    –parent_host <parent_host>, 10
    –parent_port <parent_port>, 10
    –port <port>, 10
move() (termiteOS.drivers.rpi.rpiSpeedPWM.rpiSpeedPWM method), 22

P

pos (termiteOS.drivers.rpi.rpiSpeedPWM.rpiSpeedPWM attribute), 22

R

rampUp() (termiteOS.drivers.rpi.rpiSpeedPWM.rpiSpeedPWM method), 22

reset() (termiteOS.drivers.rpi.rpiDRV8825Hat.rpiDRV8825Hat method), 20
reset() (termiteOS.drivers.rpi.rpiSpeedPWM.rpiSpeedPWM method), 22
rpiDRV8825Hat (class in termiteOS.drivers.rpi.rpiDRV8825Hat), 20
rpiSpeedPWM (class in termiteOS.drivers.rpi.rpiSpeedPWM), 21
run() (termiteOS.drivers.rpi.rpiSpeedPWM.rpiSpeedPWM method), 22
run_in_separate_process() (in module termiteOS.launch), 10

S

set_dir() (termiteOS.drivers.rpi.rpiDRV8825Hat.rpiDRV8825Hat method), 21
set_dir() (termiteOS.drivers.rpi.rpiSpeedPWM.rpiSpeedPWM method), 22
set_microsteps() (termiteOS.drivers.rpi.rpiDRV8825Hat.rpiDRV8825Hat method), 21
set_microsteps() (termiteOS.drivers.rpi.rpiSpeedPWM.rpiSpeedPWM method), 22
SetPoint() (termiteOS.drivers.rpi.rpiSpeedPWM.rpiSpeedPWM method), 22
setRPM() (termiteOS.drivers.rpi.rpiSpeedPWM.rpiSpeedPWM method), 22
setSpeed() (termiteOS.drivers.rpi.rpiSpeedPWM.rpiSpeedPWM method), 22
sleep() (termiteOS.drivers.rpi.rpiDRV8825Hat.rpiDRV8825Hat method), 21
sleep() (termiteOS.drivers.rpi.rpiSpeedPWM.rpiSpeedPWM method), 22
stepcounter() (termiteOS.drivers.rpi.rpiDRV8825Hat.rpiDRV8825Hat method), 21
stepcounter() (termiteOS.drivers.rpi.rpiSpeedPWM.rpiSpeedPWM method), 22
stop() (termiteOS.drivers.rpi.rpiSpeedPWM.rpiSpeedPWM method), 22
stopPWM() (termiteOS.drivers.rpi.rpiSpeedPWM.rpiSpeedPWM method), 22
sync() (termiteOS.drivers.rpi.rpiDRV8825Hat.rpiDRV8825Hat method), 21
sync() (termiteOS.drivers.rpi.rpiSpeedPWM.rpiSpeedPWM method), 22

T

termiteOS.drivers.rpi.rpiDRV8825Hat (module), 20
termiteOS.drivers.rpi.rpiSpeedPWM (module), 21
termiteOS.launch (module), 10
test() (termiteOS.drivers.rpi.rpiDRV8825Hat.rpiDRV8825Hat method), 21
test() (termiteOS.drivers.rpi.rpiSpeedPWM.rpiSpeedPWM method), 22
threaded() (in module termiteOS.drivers.rpi.rpiSpeedPWM), 23
toSpeed() (termiteOS.drivers.rpi.rpiSpeedPWM.rpiSpeedPWM method), 23

Y

YAMLFILE
    miteLaunch command line option, 10