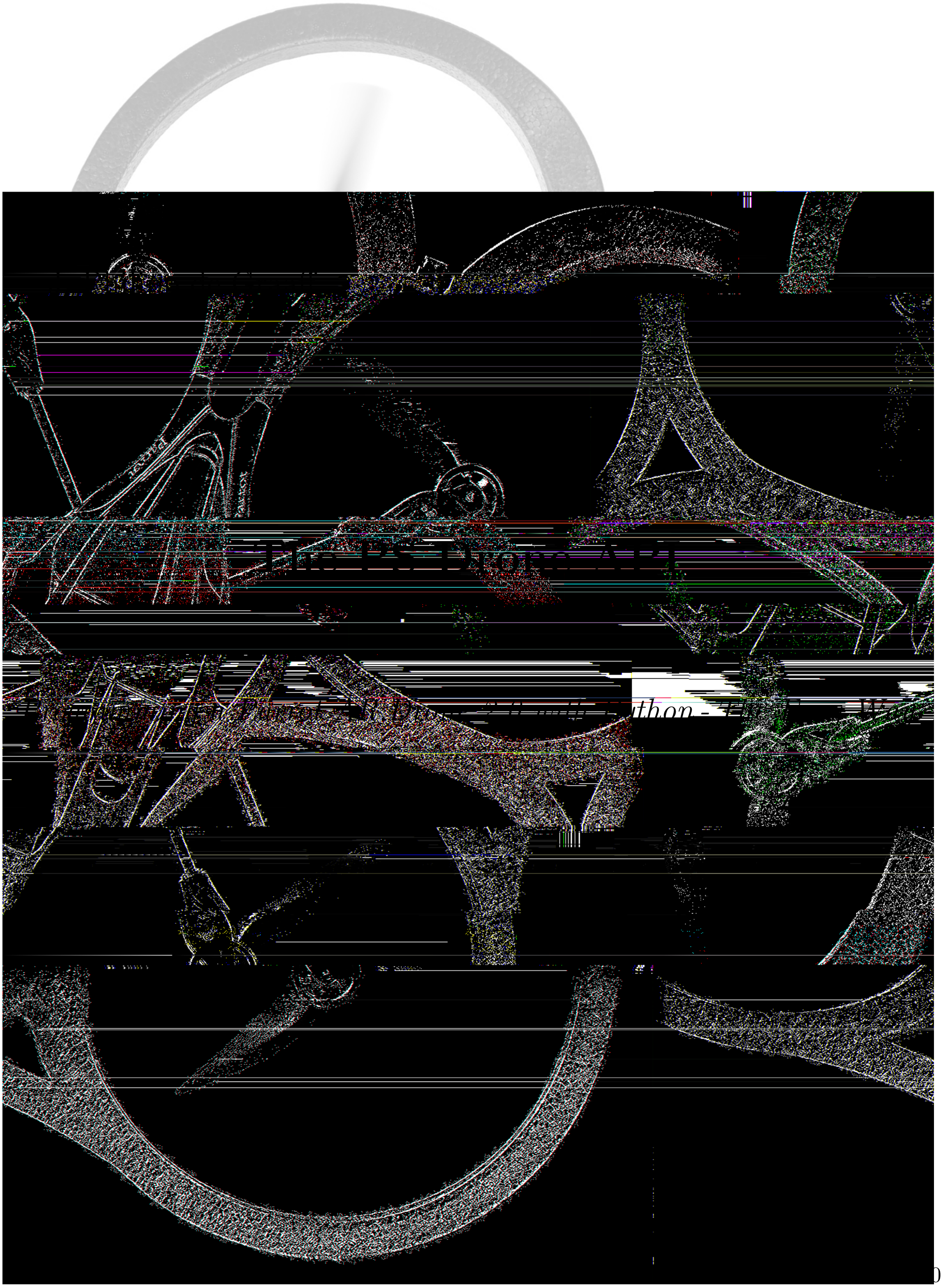

The PS Drone API

Programming a Parrot AR.Drone 2.0 with Python - The Easy Way

An open source project, available on **www.playsheep.de/drone**

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1 Introduction

PS-Drone is a full featured API, written in and for Python, for Parrot's AR.Drone 2.0. It is based on a part of a master of computer science degree dissertation and was designed to be easy to learn, but it offers the full set of the possibilities of the AR.Drone 2.0, including Sensor-Data (aka NavData), Configuration and full Video-support.

It was also designed to be as fast as Python can be. Unneeded functions can be deactivated which allows your program to run on really slow computers like Intel Atom N270 with 1.6GHz. The video function is not restricted to mere viewing; it is also possible to analyze video images data using OpenCV2.

Obviously, the PS-Drone is perfect for teaching purposes; however, even the requirements for professional purposes can be satisfied. The nomenclature refers to the official definition of parrot and its SDK, so it is easy to find some additional help in newsgroups or elsewhere on the internet by simply typing in the pre-existing keywords.

The examples are easy to understand for people with little programming experience. This Tutorial is a brief introduction for using this API, its most important commands and the most important sensor values sent by the drone. For a full list of the commands and a description of the sensor data, have a look to the PS-Drone documentary, starting in chapter 3, page 24.

PS-Drone is not compliant to Parrots AR.Drone 1.0 ! It could be possible to fly and do simple movements, but it is not possible to get any sensor-values. The PS-Drone-API does not support new models like the Bebop aka AR.Drone 3.0, due significant changes of Parrot's communication-protocol. I will provide full support as soon as I get enough donations to buy a Bebop-drone.

A port to Windows is planned, but compared to Linux, Windows does not support some relevant functions. These functions have to be implemented manually.

I am not a money-grubbing monster, but it took me several months and killed two drones to create PS-Drone and its documentation; so it would be nice to get some donations for further development (e.g. for Parrot's Bebop) and as a appreciation.
Beware, stinginess may lead to bad breath of your dog, sexually transmitted disease and watching reality-shows while listening to the greatest hits of the worst boy-groups for eternity !Think about it, a dollar is not too much. *nudge*

PS-Drone is available for free on `www.playsheep.de/drone`

1.1 Disclaimer and License

Copyright © for PS-Drone/PS-Drone-API (2012 - 2014)
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PS-Drone is available on **www.playsheep.de/drone**

The PS-Drone/PS-Drone-API is a free software package available under the **Artistic License 2.0** as seen on http://opensource.org/licenses/artistic-license-2.0 (retrieved December 2014).
If the terms of this license do not permit the full use that you propose to make of PS-Drone, please contact me for a different licensing arrangement.

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6. Disclaimer of Warranty: PS-Drone/PS-Drone-API is provided by J. Philipp de Graaff and contributors “as is” and without any express or implied warranties. I am not liable for any direct, indirect, incidental, or consequential damages arising in any way out of the use of the package.

1.2 Requirements

To program the drone you need a computer or virtual machine with a POSIX compliant operating system like Linux and an AR.Drone 2.0 of any edition. OpenCV2 is recommended and necessary for video-support. To use all functions without limitation a CPU equal 1.83GHz Intel Core Solo T1400 is needed, a 2.4GHz E6600 Core 2 Duo CPU or better is recommended for video-analysis.

PS-Drone was programmed and mostly tested on a computer with an Intel Atom N270, running a Linux Mint 13. The used drones were standard AR.Drones 2.0 by Parrot using Firmware 2.2.6 and 2.3.3.

1.3 Version

2.0.0 beta: Transferred source code from PdG-Drone to PS-Drone, some bug-fixes, changed start-up-sequence, more consistent command names, functions added, source code clean up, enhanced comments in source-code, multiple drone controlling, video initialization recovery. (Nov 2014)

2.0.0: Several minor bug-fixes and checked orthography. (Dec 2014)

2.0.1: Several major bug-fixes in movement-commands. Only perform the reset-command, if the drone is in fail-mode. Added missed *`State`*-bit. Error-messages regarding additional NavData for AR.Drones 2.0 with firmware version 2.4.8 are patched. (Dec 2014)

2 Tutorial

It is not as complicated as it might look at first sight. First, make sure you are running a POSIX compliant operating system, Linux is suggested, and make sure that python 2.x is installed. In case you want to use the drone's video, is also necessary to install OpenCV2. If you do not have any experience with Linux, try Knoppix (`http://www.knopper.net/knoppix/index-en.html`), the Linux Mint 17 live Image (`http://linuxmint.com`) or install a Linux (Linux Mint 17 MATE Edition is pretty nice) on a virtual machine (f.e. virtualBox (`https://www.virtualbox.org`)).

Parrot's AR.Drone 2.0 is by default a flying WiFi-hotspot. By default, it communicates unencrypted on a channel named `ardrone2_xxxxxx`, using IP `192.168.1.1` and offers a DHCP-Server, which means a client will (regularly) get IP `192.168.1.2`.
As a suggestion, in case you are using a LAN-connected PC, attach a wifi-router in client mode to connect to the drone and add an additional IP-address (e.g. `192.168.1.9`) to your PC.

2.1 First flight

When every everything is set up, start directly the PS-Drone-API-program which includes a simple demo program how to control the drone with your keyboard:

```
python ps_drone.py
```

Key	Movement
<space>	take-off or land
<0>	stop moving
<w>	move forward
<s>	move backward
<a>	move left
<d>	move right
<q>	turn left
<e>	turn right

Try pressing numbers, <*>, <+>, or <->, any not listed key will land the drone and end the demo.

When you are done, take a look at the first example `firstTry.py`.

```
import time
import ps_drone           #Imports the PS-Drone-API

drone = ps_drone.Drone()  #Initials the PS-Drone-API
drone.startup()           #Connects to the drone and starts subprocesses

drone.takeoff()           #Drone starts
time.sleep(7.5)           #Gives the drone time to start

drone.moveForward()       #Drone flies forward...
time.sleep(2)             #...  for two seconds
drone.stop()              #Drone stops...
time.sleep(2)             #...  needs, like a car, time to stop

drone.moveBackward(0.25)  #Drone flies backward with a quarter speed...
time.sleep(1.5)           #...  for one and a half seconds
drone.stop()              #Drone stops
time.sleep(2)

drone.setSpeed(1.0)       #Sets default moving speed to 1.0 (=100%)
print drone.setSpeed()    #Shows the default moving speed

drone.turnLeft()          #Drone moves full speed to the left...
time.sleep(2)             #...  for two seconds
drone.stop()              #Drone stops
time.sleep(2)

drone.land()              #Drone lands
```

Listing 2.1: Sourcecode of sample `firstTry.py`

Before `drone.startup()`, it is possible to configure the PS-Drone, for example, to change the drone's IP. Please take a look at the documentary, in chapter 3, page 24, for all options.

`startup()` connects to the drone, configures the basics and activates the sensor-datastream also known as "NavData". A documentation about the drone's sensors and the returned values will also be in this documentary, in chapter 3.4, page 29.

The command `takeoff()` makes the drone fly. After the drone has reached its hovering state (at around 75cm), it runs some internal calibrations. However, usually the take-off-sequence takes around seven seconds altogether, movement-commands before a clearly completed take-off might cause unexpected (but not critical) behavior.
The commands `land()` makes the drone land.

Note: Only these commands enable the drone to take off, go up into the air, descend again and finally come back to the ground, just using the commands `moveUp()` or `moveDown()` would not bring the expected success.

The basic movement-commands are:

```
moveForward(val)
moveBackward(val)
moveLeft(val)
moveRight(val)
moveUp(val)
moveDown(val)
turnLeft(val)
turnRight(val)
stop()
```

The values for these basic movement-commands determine the speed of the movement and are optional. The values should be between `0.0` and `1.0` as they represent the drone's speed from 0% to 100%. If you do not set the speed-value, the drone will move with its default speed. You can alter this default speed (which is preset by `0.2`) by using the command `setSpeed(val)`.

The command `stop()` stops the drone's movement and makes it hold its position. Setting a movement-command with the speed-value `0.0` will not have the same effect; the drone will glide in its last (horizontal) direction, just getting slower due to air drag (see also next section for further information).

Due to its firmware, it is not possible for the drone to hold its exact position while turning on its own axis; it tends to move sideways. The extent of these unwanted movements depends on the condition of the propellers and the drone in general (the more damaged, the stronger the drifting-effects).

By default, the AR.Drone 2.0 continues to perform the last movement-command forever, until it receives a new movement-command. Therefore, PS-Drone has "self-control" as a security feature. It means that if your program crashes, this API detects it, sends the command to land to the drone and shuts it down properly. In case the PS-Drone has no chance to react (for example because your computer crashed or the drone has flown too far away) you are doomed ! By the way: Houseplants and cats do not like being attacked by an uncontrolled drone on the rampage - believe me !
However, it is not necessary to land and shut down the drone at the end of your program.

2.2 Glide vs stop and a better startup-sequence

In this section, the term "thrust" is also used for speed; because, basically, speed is caused by thrust.

The following example `glideNstop.py` shows the difference between active stopping and holding position on the one hand; and reducing the thrust to `0.0` on the other. Active stopping will cause the drone to hold position, while giving no thrust will make the drone to glide on; it will just get slower due to air drag. If you want to experience the difference between the two yourself, start the program, push the flying drone and see what happens.

```
##### Suggested clean drone startup sequence #####
import time, sys
import ps_drone           #Imports the PS-Drone-API

drone = ps_drone.Drone()  #Initials the PS-Drone-API
drone.startup()           #Connects to the drone and starts subprocesses

drone.reset()             #Sets drone's LEDs to green when red
while (drone.getBattery()[0]==-1):  time.sleep(0.1)   #Reset completed ?
print¨Battery:¨+str(drone.getBattery()[0])+¨% ¨+str(drone.getBattery()[1])¨
if drone.getBattery()[1]==¨empty¨:  sys.exit()

drone.useDemoMode(True)       #15 basic datasets per second (default)
drone.getNDpackage([¨demo¨])  #Packets, which shall be decoded
time.sleep(0.5)               #Give it some time to fully awake

drone.takeoff()               #Fly, drone, fly !
while drone.NavData[¨demo¨][0][2]:  time.sleep(0.1) #Still in landed-mode?

##### Mainprogram #####
print ¨Drone is flying now, land it with any key but <space>¨

gliding = False
print ¨Drone is holding its position, toggle to glide with <space>-key.¨

end = False
while not end:
    key = drone.getKey()            #Get a pressed key
    if key == ¨ ¨:
        if gliding:
            gliding = False
            drone.stop()            #Stop and hold position
            print ¨Drone is holding its position¨
        else:
            gliding = True
            drone.moveForward(0)    #Do not fly actively in any direction
            print ¨Drone is gliding¨
    elif key:  end = True           #End this loop
    else:      time.sleep(0.1)      #Wait until next looping
```

Listing 2.2: Sourcecode of sample `glideNstop.py`

For a clean start up some additional code has been added, because a just time-based controlling is rarely not a good solution. As a suggestion just copy and paste this start up-sequence to your own code.

The first lines remain more or less the same. Resetting the drone makes it work again, if the drone's firmware blocks flying, indicated by red LEDs. A reset takes a while and the drone does not send data in the meantime. When sending data again (the battery status will be checked here), the drone has almost finished, but still needs a little time.

The commands `useDemoMode(val)` and `getNDpackage(val)` will be explained later, the values `True` and `[¨demo¨]` are standard-settings anyway.
However, it could happen that you require more data and faster. Therefore, a brief explanation beforehand: The drone sends its sensor-/NavData in a large bunch. This includes several packets called `¨demo¨`, `¨time¨`, `¨altitude¨` and so on, with specified data. In demo-mode, there are only the packages `¨demo¨` and `¨vision_detect¨` available,

both 15 times per second; most of the time, this is enough and perfect for learning or debugging. Switching off the demo-mode means all NavData-packages are available, 200 times per second.
Available NavData-values are always stored in an array called ¨*NavData*¨. First dimension is the name of the small package the values are stored in. Position *[0][2]* stores the drone's *landed*-status-tag. If not set anymore, the drone is ready for action.

It has already been mentioned, that a take-off takes around seven seconds. However, this example uses the drone's flight-status. There will be a further explanation later.

The command *getKey()* has been added for convenience and has technically nothing to do with the drone. Use it to get the value of a pressed key, without worrying about timing, deadlocks and other annoying effects.
Notice that there is no command to land the drone, PS-Drone does it for you at the end of your program. The example stops when a key was pressed that is not <*space*>.

It is recommended to implement an emergency stop in your code which will land the drone by pressing a key. Also a powerpoint-remote control is suggested in order to be more mobile; a pressed key on that remote control is like pressing a key or a key chain on the keyboard and simple to implement.

2.3 Enhanced movement

It is now time for the last important movement and movement-related commands as shown in example *moveTurn.py* in listing 2.3.

The *move()*-command combines all the basic movements that have already been introduced. So you can make the drone fly to the right, backwards, down and turn to the right at the same time; and with different speed in each direction.

The *move()*-command expects four values for the directions *'right'*, *'forward'*, *'up'* and *'turn right'*: *move(right, forward, up, turn right)*

Like the basic movements, the range for the speed-value is *0.0* to *1.0*, representing 0% to 100% of the drone's top speed. By setting a negative value, the drone will reverse its direction; for example, the value *-0.5* for forward-speed lets the drone fly backwards.

The command *turnAngle()* lets the drone turn to the left or the right in the exact given degrees. This command requires values for a certain degree in order to turn to the right and the speed to do so. If you use a negative degree value, the drone rotates to the left. *turnAngle()* blocks which means that following commands are not processed until *turnAngle()* has been executed. So there is no clean way to stop the movement, for example as an emergency stop, until its done.
Optional, you can set a value for accuracy, the allowed mismatch of the given degree. The default value is ±0.005° and ±0.1°, depending on the drone's Demo-Mode-status. The less accurate the turn is, the faster is it done.
The maximum turn is a half rotation; the angle-value can be at most ±180.0°.

Known bug: this command is not able to perform an exact turn of 180.0°; instead, the drone tries to find its destination angle until the battery is dead and without the possibility to stop the drone neatly. This bug will be fixed soon.

```
##### Suggested clean drone startup sequence #####
import time, sys
import ps_drone            #Imports the PS-Drone-API

drone = ps_drone.Drone()  #Initials the PS-Drone-API
drone.startup()           #Connects to the drone and starts subprocesses

drone.reset()             #Sets drone's LEDs to green when red
while (drone.getBattery()[0]==-1):  time.sleep(0.1)   #Reset completed ?
print¨Battery:¨+str(drone.getBattery()[0])+¨% ¨+str(drone.getBattery()[1])¨
if drone.getBattery()[1]==¨empty¨:  sys.exit()

drone.useDemoMode(True)       #15 basic datasets per second (default)
drone.getNDpackage([¨demo¨])  #Packets, which shall be decoded
time.sleep(0.5)               #Give it some time to fully awake

drone.trim()                  #Recalibrate sensors
drone.getSelfRotation(5)      #Auto-alteration-value of gyroscope-sensor
print ¨Auto-alternation:  ¨+str(drone.selfRotation)+¨deg/sec¨

drone.takeoff()
while drone.NavData[¨demo¨][0][2]:  time.sleep(0.1)

##### Mainprogram #####
print ¨Drone is flying now¨

leftRight      =-0.02        #Move with 2% speed to the left
backwardForward=-0.1         #Move with 10% speed backwards
downUp         =0.3          #Move with 30% speed upward
turnLeftRight  =1            #Turn full speed right
drone.move(leftRight, backwardForward, downUp, turnLeftRight) #Do movement

timeToFlight   =2.5          #Time to move at all
refTime        =time.time()  #Start-time
end            =False
while not end:
    if drone.getKey():  end=True
    if time.time()-refTime>=timeToFlight: end=True

print ¨Drone stopped movement¨
drone.stop()
time.sleep(2)

print ¨Drone turns 120 degree to the left¨
drone.turnAngle(-120,1,1)     #Turn 120 to the left, full speed, 1 accuracy
```

Listing 2.3: Sourcecode of sample `moveTurn.py`

In order to hold position and not drift away slowly in any direction, the drone's sensors for orientation need to be calibrated on horizontal ground. The drone's firmware does a good job recalibrating these sensors in case of inaccuracy, using the sensors for acceleration. If it is ne0.90 Ags(If)]TJ -oDpn.8237(usi7g)-336(the)-7gusi7gusi7g miti sample

This command expects the time to measure as value. Of cause: the more time you give to measure the more accurate is the result. *turnAngle()* considers the value of *selfRotation* for exact turns.

Note: With the firmware version 2.2.6, the automatic value alteration of the gyroscope-sensor was around 0.0185°/sec. Parrot fixed this auto alteration with the firmware version 2.3.3, but now the entire drone rotates, about 360° in 20 minutes, without any recognition of the gyroscope-sensor. If you yet have not updated, the suggestion is to stay with version 2.2.6. Firmware-version 2.4.8 has not tested, yet.

2.4 Using the drone's sensors

Parrot calls the AR.Drone sensor data "NavData", so we do, too.

Starting with some theory:
NavData is sent in one block including the sensor-measurements and some status informations it consists of bunch of 28 packages, each containing a specific set of values. The packages are named in this API as they are named by Parrot in their SDK.

The available packages are:
¨demo¨, *¨time¨*, *¨pwm¨*, *¨raw_measures¨*, *¨phys_measures¨*, *¨gyros_offsets¨*, *¨altitude¨*, *¨magneto¨*, *¨euler_angles¨*, *¨references¨*, *¨rc_references¨*, *¨vision_detect¨*, *¨vision¨*, *¨vision_raw¨*, *¨vision_of¨*, *¨vision_perf¨*, *¨trackers_send¨*, *¨video_stream¨*, *¨hdvideo_stream¨*, *¨games¨*, *¨trims¨*, *¨pressure_raw¨*, *¨wind_speed¨*, *¨kalman_pressure¨*, *¨watchdog¨*, *¨wifi¨*, *¨adc_data_frame¨*, *¨zimmu_3000¨* and *¨chksum¨*.

For some reasons from, I am going to speak about *"time-units"* now. A time-unit (TU) is the time from getting a NavData to getting the next. The drone knows two modes for sending its NavData, a "demo"- and a "full"-mode. Depending on its mode, there are 15 or 200 NavData sent per second which means that a second is divided into 15, respectively 200 time-units.

The AR.Drone 2.0 sends its NavData in a UDP-package. This means that the drone keeps on sending without caring about whether its NavData is being received. So there is a possibility of lost or false information. However, it has become apparent that no false NavData is received, but 3% or more gets lost.

There is also a difference between the available NavData-packages depending on whether the demo-mode is enabled or disabled:
With enabled demo-mode, just the packages *¨demo¨*, *¨vision_detect¨* and *¨chksum¨* are (by default) available 15 times a second; however, most of the time, this is enough.
With disabled demo-mode, (by default) all 28 packages are sent 200 times per second.

State-tags are also available. They are, like most packages, not very important right now, but are always sent with the NavDatas header.
The drone's state and its NavData are stored in the variable *State* or respectively *NavData*. The variable *NavDataCount* shows the count of the drone's sent NavData.

There are also the variables `NavDataTimeStamp` and `NavDataDecodingTime`, representing the time when the last NavData was received by the PS-Drone-API and how long it took to decode it. Make sure that decoding time is less then a time-unit.

```
##### Suggested clean drone startup sequence #####
import time, sys
import ps_drone           #Imports the PS-Drone-API

drone = ps_drone.Drone()  #Initials the PS-Drone-API
drone.startup()           #Connects to the drone and starts subprocesses

drone.reset()             #Sets drone's LEDs to green when red
while (drone.getBattery()[0]==-1):  time.sleep(0.1)   #Reset completed ?
print¨Battery:¨+str(drone.getBattery()[0])+¨%¨+str(drone.getBattery()[1])¨
drone.useDemoMode(True)       #15 basic datasets per second (default)
drone.getNDpackage([¨demo¨])  #Packets, which shall be decoded
time.sleep(0.5)               #Give it some time to fully awake

##### Mainprogram #####
NDC =   drone.NavDataCount
state = 0
end =   False
while not end:
    while drone.NavDataCount==NDC: time.sleep(0.001) #Wait for NavData
    if drone.getKey():
        state+=1
        if state==1:  drone.addNDpackage([¨demo¨]) #Add ¨demo¨ to list
        if state==2:  drone.getNDpackage([¨all¨])  #Get these packages
        if state==3:  drone.delNDpackage([¨all¨])  #Clear decoder-list
        if state==3:  drone.useDemoMode(False)     #switch to full-mode
        if state==4:  drone.addNDpackage([¨demo¨])
        if state==5:  drone.getNDpackage([¨all¨])
        if state>5:   sys.exit()

    print "-------------------"
    if state==0:  print¨##### Demo Mode: On    NavData-Packages: None¨
    if state==1:  print¨##### Demo Mode: On    NavData-Packages: Demo¨
    if state==2:  print¨##### Demo Mode: On    NavData-Packages: All¨
    if state==3:  print¨##### Demo Mode: Off   NavData-Packages: None¨
    if state==4:  print¨##### Demo Mode: Off   NavData-Packages: Demo¨
    if state==5:  print¨##### Demo Mode: Off   NavData-Packages: All¨

    if drone.NavDataCount-NDC>1:
        print¨Lost ¨+str(drone.NavDataCount-NDC-1)+¨ NavData¨
    print¨Number of package : ¨+str(drone.NavDataCount)
    print¨Receifetime :      ¨+str(drone.NavDataTimeStamp)+¨, \t¨\
            +str(time.time()-drone.NavDataTimeStamp)+¨ sec ago¨
    print¨Time to decode :   ¨+str(drone.NavDataDecodingTime)
    print¨Included packages : ¨+str(drone.NavData.keys())
    print¨State-data :       ¨+str(drone.State)
    try:    print¨Demo-data :        ¨+str(drone.NavData["demo"])
    except: pass
    NDC=drone.NavDataCount
```

Listing 2.4: Sourcecode of sample `firstNavData.py`

While a program-loop using NavData, it is suggested to wait for the next time-unit by using the NavDataCount as shown in the previous example.

`getNDpackage()` sets the exact list of packages which will be decoded.
With the commands `addNDpackage()` and `delNDpackage()` a couple of packages can be added to, or deleted from the decoding list.

You start, for example, with `getNDpackage([¨demo¨,¨time¨])` and do later `addNDpackage([¨altitude¨])` and `delNDpackage([¨time¨])`, the decoding would as if setting `getNDpackage([¨demo¨,¨altitude¨])`. There is no need to put the entries into a particular order.

Possible entries are the names of the packages, but also `¨all¨` for the complete set of packages:
`¨demo¨`, `¨time¨`, `¨pwm¨`, `¨raw_measures¨`, `¨phys_measures¨`, `¨gyros_offsets¨`, `¨altitude¨`, `¨magneto¨`, `¨euler_angles¨`, `¨references¨`, `¨rc_references¨`, `¨vision_detect¨`, `¨vision¨`, `¨vision_raw¨`, `¨vision_of¨`, `¨vision_perf¨`, `¨trackers_send¨`, `¨video_stream¨`, `¨hdvideo_stream¨`, `¨games¨`, `¨trims¨`, `¨pressure_raw¨`, `¨wind_speed¨`, `¨kalman_pressure¨`, `¨watchdog¨`, `¨wifi¨`, `¨adc_data_frame¨`, `¨zimmu_3000¨`, `¨chksum¨` and `¨all¨`.

Most of the packages and their included values are not very well documented; this tutorial will focus on the most important packages. For further and more comprehensive information, please take a look at chapter 4, starting on page 47, and at the sourcecode of `ps_drone.py`.

Note: Some measurements are not available when the drone is not in flight-mode. If it is on the ground, some values will stay "*0*".

This tutorial will show the most important values for the packages, like `State`, `¨demo¨`, `¨magneto¨`, `¨pressure_raw¨`, `¨altitude¨`, `¨kalman_pressure¨`, `¨wind_speed¨`, `¨pwm¨` and `¨vision_detect¨`.

`State`:

No	Name	0:	1:
[10]	NavData demo	All NavData	NavData demo
[12]	Motors status	OK	Problem
[15]	Batterystatus	OK	Too low
[18]	Magnetometer calib	No calibration needed	Calibration needed
[20]	Wind mask	OK	Too much wind
[21]	Ultrasonic sensor	OK	Deaf
[31]	Emergency landing	No emergency	Emergency

¨*demo*¨-package:
Shows the most important values at all, like some status-tags and information about slope, acceleration and battery charge.

Pos	Note
[0][2]	Status-tag for ¨landed¨ - Drone is on the ground or not fully flying
[0][3]	Status-tag for ¨flying¨ - Drone is flying
[0][4]	Status-tag for ¨hovering¨ - Name should be: ¨landing¨, the drone is landing
[1]	Battery-status in percent
[2][0]	Pitch in degree (front/back)
[2][1]	Roll in degree (left/right)
[2][2]	Yaw in degree (turn)
[3]	Altitude in cm (only when flying)
[4][0]	Estimated speed in X in mm/s (forward/backward, only when flying)
[4][1]	Estimated speed in Y in mm/s (left/right, only when flying)
[4][2]	Estimated speed in Z in mm/s (up/down, only when flying)

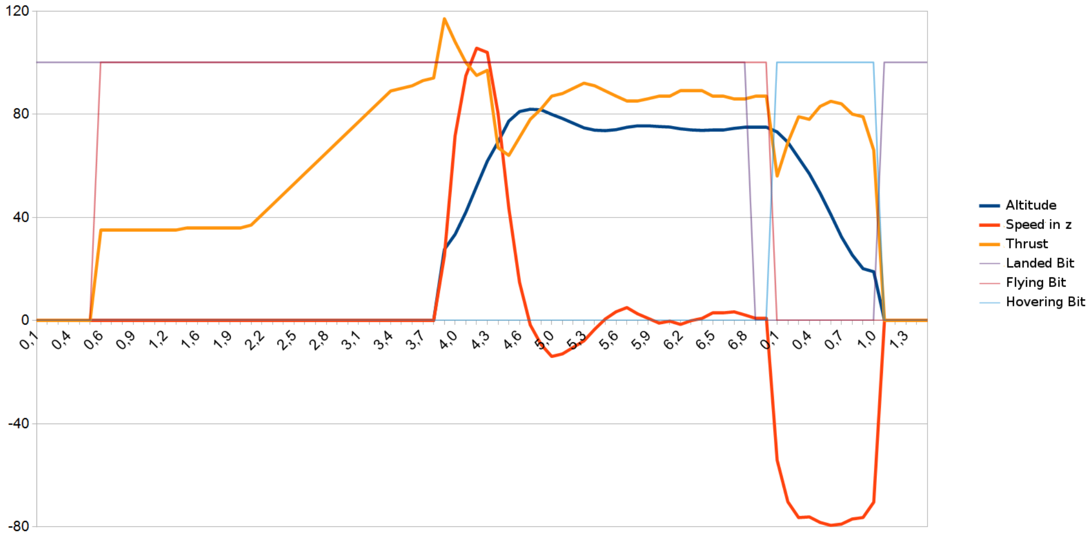


Figure 2.1: Status-tags while taking off and landing of an AR.Drone 2.0

¨*magneto*¨-package:

Pos	Note
[0]	Magnetometer values for X, Y and Z
[1]	Raw magnetometer values for X, Y and Z

¨*pressure_raw*¨-package:

Pos	Note
[0]	A raw value, the height is calculable, the higher the drone flies the lower the value (about 80cm per count)

¨*`altitude`*¨-package:

Pos	Note
[3]	Altitude in mm

¨*`kalman_pressure`*¨-package:

Pos	Note
[1]	Estimated height (only when flying)

¨*`wind_speed`*¨-package:

Pos	Note
[0]	Windspeed (only when flying)
[1]	Angle of wind (only when flying)

¨*`pwm`*¨-package:
The motors are controlled by pulse-wide modulation. The higher the value, the higher is the rotation velocity of the propellers.

Pos	Note
[0][0]	Shows the actual pwm-value for the motor on the front left
[0][1]	Shows the actual pwm-value for the motor on the front right
[0][2]	Shows the actual pwm-value for the motor on the back right
[0][3]	Shows the actual pwm-value for the motor on the back left

¨*`vision_detect`*¨-package:
Gives information on up to four detected markers. In order to detect markers, some configurations needs to be done first.

Pos	Note
[0]	Number of detected marker (max 4)
[1]	List of the types of detected markers
[2]	List of the X-positions of detected markers
[3]	List of the Y-positions of detected markers
[4]	List of the dimensional width of detected markers
[5]	List of the dimensional depth of detected markers
[6]	List of the distances of detected markers
[7]	List of the orientation angles of detected markers
[9]	List of the rotations of detected markers

¨*`chksum`*¨-package:

Pos	Note
[0]	Checksum
[1]	Quality: incorrect/correct

```
##### Suggested clean drone startup sequence #####
import time, sys
import ps_drone             #Imports the PS-Drone-API

drone = ps_drone.Drone()    #Initials the PS-Drone-API
drone.startup()             #Connects to the drone and starts subprocesses

drone.reset()               #Sets drone's LEDs to green when red
while (drone.getBattery()[0]==-1):  time.sleep(0.1)   #Reset completed ?
print"Battery:"+str(drone.getBattery()[0])+"% "+str(drone.getBattery()[1])"
drone.useDemoMode(False)    #Give me everything...fast
drone.getNDpackage(["demo","pressure_raw","altitude","magneto","wifi"])
time.sleep(0.5)             #Give it some time to fully awake

##### Mainprogram #####
NDC =   drone.NavDataCount
end =   False
while not end:
    while drone.NavDataCount==NDC: time.sleep(0.001) #Wait for NavData
    if drone.getKey():             end=True
    NDC=drone.NavDataCount

    print"-----------"
    print"Aptitude[X,Y,Z]:           "+str(drone.NavData["demo"][2])
    print"Altitude/sensor/pressure: "+str(drone.NavData["altitude"][3])\
                                    +"/"+str(drone.State[21])+"/"\
                                    +str(drone.NavData["pressure_raw"][0])
    print"Megnetometer[X,Y,Z]:       "+str(drone.NavData["magneto"][0])
    print"Wifi link quality:         "+str(drone.NavData["wifi"])
```

Listing 2.5: Sourcecode of sample `getNavData.py`

2.5 Configurate the drone

Before working with video, it is necessary to understand some basic configuration issues. Depending on configuration-settings the drone behaves differently, so is e.g. the command `useDemoMode()`, beside others, an alias for a reconfiguration of the drone.

The AR.Drone 2.0 has 104 information and configurable options. Some entries give a status and are only readable, like `"general:flight_time"`, some are editable, e.g. `"general:ardrone_name"`. These simple text strings, more or less, consist of two parts; the first part is the option's name, containing the category and the option, the second part is the set value.

The PS-Drone supports you by organizing the complex procedures of communication and its handling, so a reconfiguration is not so tricky. You cannot "brick" the drone, but it is always better to know what you are doing.
It is important to know that reconfigurations are set with a delay, depending on the quantity of configurations to set at once. Depending on the drone's firmware (e.g. version 2.3.3) that procedure is optimized by temporarily sending extra NavData in between.
Furthermore, it happens once in a while that the drone's reactions are inconsistent after an alteration: The drone claims that the value has been set, but it maintains its previous

setting. It seems that this concerns mainly video: Sometimes a switch to ground-camera has been acknowledged, but the front-view is still visible.

Here is an example how to get and set the drones configurations:

```
##### Suggested clean drone startup sequence #####
import time, sys
import ps_drone                #Imports the PS-Drone-API

drone = ps_drone.Drone()       #Initials the PS-Drone-API
drone.startup()                #Connects to the drone and starts subprocesses

drone.reset()                  #Sets drone's LEDs to green when red
while (drone.getBattery()[0]==-1):  time.sleep(0.1)    #Reset completed ?
print¨Battery:¨+str(drone.getBattery()[0])+¨% ¨+str(drone.getBattery()[1])¨
drone.useDemoMode(True)       #15 basic datasets per second (default)
time.sleep(0.5)               #Give it some time to fully awake

##### Mainprogram #####
#Just list the configuration, it is already synchronized
for i in drone.ConfigData:     print i

#Take a closer look at an option...
print¨\nSample:¨,
for i in drone.ConfigData:
    if i[0]==¨control:altitude_max¨:
        print str(i)+¨ Count: ¨+str(drone.ConfigDataCount)\
                    +¨ Timestamp: ¨+str(drone.ConfigDataTimeStamp)

#...  and change it
print¨-----¨
print¨Setting \¨control:altitude_max\¨ to \¨2999\¨...¨
CDC =     drone.ConfigDataCount
NDC =     drone.NavDataCount
refTime = time.time()
drone.setConfig(¨control:altitude_max¨,¨2999¨)       #Change of an option
while CDC==drone.ConfigDataCount: time.sleep(0.001) #Wait until it is done
print¨ Finished after ¨+str(time.time()-refTime)+¨ seconds, ¨\
          +str(drone.NavDataCount-NDC)+¨ NavData where received meanwhile.¨
for i in drone.ConfigData:
    if i[0]==¨control:altitude_max¨:
        print str(i)+¨ Count: ¨+str(drone.ConfigDataCount)\
                    +¨ Timestamp: ¨+str(drone.ConfigDataTimeStamp)

#Change an option a couple of times
print¨\n-----¨
print¨Setting \¨control:altitude_max\¨ to \¨2996\¨,then to \¨2997\¨,\
                    \¨2998\¨,\¨2999\¨ and \¨3000\¨...¨
CDC =     drone.ConfigDataCount
NDC =     drone.NavDataCount
refTime = time.time()
drone.setConfig(¨control:altitude_max¨,¨2996¨)#Request change of an option
drone.setConfig(¨control:altitude_max¨,¨2997¨)#  request change again
drone.setConfig(¨control:altitude_max¨,¨2998¨)#  and again.
drone.setConfig(¨control:altitude_max¨,¨2999¨)#PS-Drone detects and deletes
drone.setConfig(¨control:altitude_max¨,¨3000¨)#  doubles and sets only last
while CDC==drone.ConfigDataCount: time.sleep(0.001) #Wait until it is done
print¨ Finished after ¨+str(time.time()-refTime)+¨ seconds, ¨\
          +str(drone.NavDataCount-NDC)+¨ NavData where received meanwhile.¨
```

```
for i in drone.ConfigData:
    if i[0]==¨control:altitude_max¨:
        print str(i)+¨Count: ¨+str(drone.ConfigDataCount)\
                    +¨Timestamp: ¨+str(drone.ConfigDataTimeStamp)

print¨\n-----¨
print¨Setting \¨control:altitude_max\¨ to \¨2980\¨,\
              \¨control:altitude_min\¨ to \¨499\¨ and \
              \¨video:video_on_usb\¨ to \¨false\¨...¨
CDC =     drone.ConfigDataCount
NDC =     drone.NavDataCount
refTime = time.time()
drone.setConfig(¨control:altitude_max¨,¨2980¨)#Change of an option
drone.setConfig(¨control:altitude_min¨,¨499¨) #Change of an other option
drone.setConfig(¨video:video_on_usb¨,¨false¨) #Change of an other option
while CDC==drone.ConfigDataCount: time.sleep(0.001) #Wait until it is done
print¨ Finished after ¨+str(time.time()-refTime)+¨seconds, ¨\
          +str(drone.NavDataCount-NDC)+¨NavData where received meanwhile.¨
for i in drone.ConfigData:
    if i[0]==¨control:altitude_max¨ or i[0]==¨control:altitude_min¨\
                                    or i[0]==¨video:video_on_usb¨:
        print str(i)+¨Count: ¨+str(drone.ConfigDataCount)\
                    +¨Timestamp: ¨+str(drone.ConfigDataTimeStamp)

print¨\n-----¨
print¨Just resyncing the drones configuration...¨
CDC =     drone.ConfigDataCount
NDC =     drone.NavDataCount
refTime = time.time()
drone.getConfig()
while CDC==drone.ConfigDataCount: time.sleep(0.001) #Wait until it is done
print¨ Finished after ¨+str(time.time()-refTime)+¨seconds, ¨\
          +str(drone.NavDataCount-NDC)+¨NavData where received meanwhile.¨
```

Listing 2.6: Sourcecode of sample `firstConfig.py`

For reconfiguration you mainly need two commands: `getConfig()` and `setConfig()`

`getConfig()` will synchronize the local copy of the drone's configuration and stores the list in the variable `ConfigData`, along with the time when it was received in `ConfigDataTimeStamp` and the count of received configurations in `ConfigDataCount`. The fetch of the drone's configuration works not in real-time and may take up to 0.15 seconds.

The command `setConfig(¨option¨,¨value¨)` sets the value for the given option. The name of the option has to be a text-string. As alterations are not in real-time, in order to optimize the configuration-speed and for convenience, the request is added to a queue and sent one after another without you having to care about. PS-Drone tests the queue for double entries of the same option and initiates the latest change to prevent unnecessary delay.

If you try to set an unknown option, the drone will reject the request; however, if the value is unknown, the drone sets an unpredictable value itself. When the queue is done, the local copy of the drone's configuration is automatically updated analogue to command `getConfig()`.

Not all of the options and their possible values are guessable, some are not even documented by Parrot. Take a look at chapter 5, starting on page 57 to find the known descriptions of the entries.

A mode for multi-configuration is also existing. It is mainly interesting for using video and it contains the configurations for the set sessions. It is not really necessary to care about how it works; however, once you have started using it, you must continue to use it until your program has finished or until you have switched back to single-configuration.

```
##### Suggested clean drone startup sequence #####
import time, sys
import ps_drone             #Imports the PS-Drone-API

drone = ps_drone.Drone()    #Initials the PS-Drone-API
drone.startup()             #Connects to the drone and starts subprocesses

drone.reset()               #Sets drone's LEDs to green when red
while (drone.getBattery()[0]==-1):  time.sleep(0.1)   #Reset completed ?
print¨Battery:¨+str(drone.getBattery()[0])+¨% ¨+str(drone.getBattery()[1])¨
drone.useDemoMode(True)     #15 basic datasets per second (default)
time.sleep(0.5)             #Give it some time to fully awake

##### Mainprogram #####
print¨default IDs:¨,
for i in drone.ConfigData:
    if i[0].count(¨control:¨)==1 and i[0].count(¨_id¨)==1:  print str(i)

print¨set default multiconfiguration:
drone.setConfigAllID()¨
CDC = drone.ConfigDataCount
while CDC==drone.ConfigDataCount: time.sleep(0.001) #Wait until it is done
for i in drone.ConfigData:
    if i[0].count(¨control:¨)==1 and i[0].count(¨_id¨)==1:  print str(i)

print¨Setting \¨control:altitude_max\¨ to \¨2999\¨...¨
drone.setMConfig(¨control:altitude_max¨,¨2999¨)      #Change of an option
while CDC==drone.ConfigDataCount: time.sleep(0.001) #Wait until it is done
for i in drone.ConfigData:
    if i[0]==¨control:altitude_max¨:  print str(i)
```

Listing 2.7: Sourcecode of sample `multiConfig.py`

As you see, multi-configuration does not really differ from normal configuration.

After having enabled multi-configuration by sending pre-set IDs with the command `setConfigAllID()`, you change configurations by using the command `setMConfig()` which has the same usage and behaviour as `setConfig()`.

2.6 Detecting markers

The AR.Drone 2.0 supports detecting certain machine-parsable images using its cameras. These particular images are called “tags” or “markers”. It is an integrated feature of the drone able to detect up to four markers; their position, distance to the drone and, depending on the marker, their orientation at the same time.
The cameras of the drone (tested with a standard AR.Drone 2.0) are not really good, so there is a limited range of luminance in which it is possible to get acceptable results. Also spotlights and reflections of marker-printouts are a serious problem.

The marker that comes with the drone is the “black and white oriented roundel”. It is recommended for the following tests, not least because the drone detects it most certainly. The tag “Roundel” has also been tested, but, because it contains specific colors, it is harder for the drone to detect it.

```
##### Suggested clean drone startup sequence #####
import time, sys
import ps_drone              #Imports the PS-Drone-API

drone = ps_drone.Drone()     #Initials the PS-Drone-API
drone.startup()              #Connects to the drone and starts subprocesses

drone.reset()                #Sets drone's LEDs to green when red
while (drone.getBattery()[0]==-1):  time.sleep(0.1)    #Reset completed ?
print"Battery:"+str(drone.getBattery()[0])+"% "+str(drone.getBattery()[1])"
drone.useDemoMode(True)                    #15 basic datasets per second
drone.getNDpackage(["demo","vision_detect"]) #Packets to decoded
time.sleep(0.5)                            #Gives time to fully awake

##### Mainprogram #####
#Setting up detection...
drone.setConfig("detect:detect_type", "3")          #Universal detection
drone.setConfig("detect:detections_select_h", "128")#Front:Oriented Roundel
drone.setConfig("detect:detections_select_v", "0")  #Ground:None
CDC = drone.ConfigDataCount
while CDC==drone.ConfigDataCount: time.sleep(0.001) #Wait until it is done

#Get detections
end =   False
while not end:
    while drone.NavDataCount==NDC: time.sleep(0.001) #Wait for NavData
    if drone.getKey():            end=True
    tagNum=drone.NavData["vision_detect"][0]    #No of found tags
    tagX  =drone.NavData["vision_detect"][2]    #Horizontal position(s)
    tagY  =drone.NavData["vision_detect"][3]    #Vertical position(s)
    tagZ  =drone.NavData["vision_detect"][6]    #Distance(s)
    tagRot=drone.NavData["vision_detect"][7]    #Orientation(s)

#Show detections
    if tagNum:
        for i in range (0,tagNum):
            print "Tag no "+str(i)+" :  X="+str(tagX[i])+" Y="+str(tagY[i])\
                   +" Dist="+str(tagZ[i])+" Orientation="+str(tagRot[i])
    else:   print "No tag detected"
```

Listing 2.8: Sourcecode of sample `firstTagDetection.py`

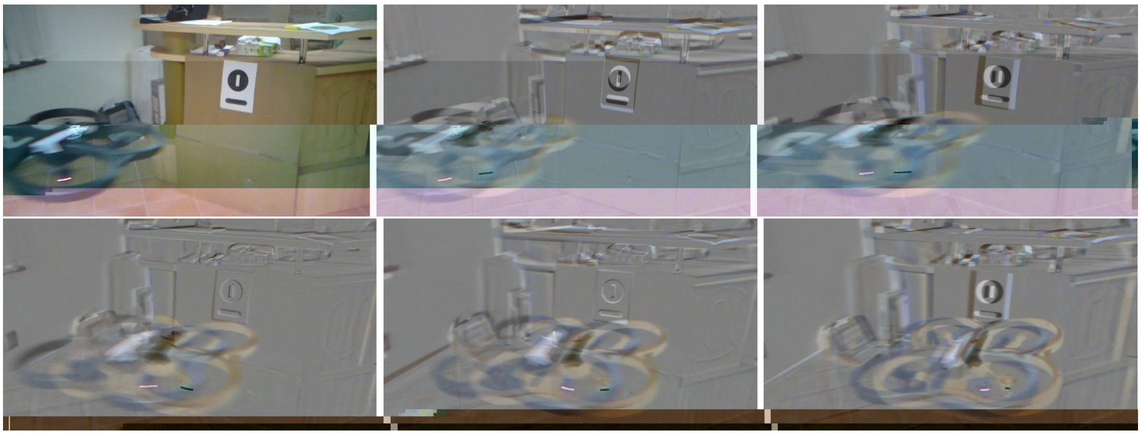
At first, the detection has to be enabled by reconfiguring option *¨detect:detect_type¨* from *¨0¨* to *¨10¨*.
Options *¨detect:detections_select_h¨* and *¨detect:detections_select_v¨* limit the detection to a specific set of available tags for the front or respectively the ground camera. Each available tag has a certain number, e.g. “Black and white oriented roundel” has *¨128¨* and “Roundel” has *¨2¨*. To detect both, set the option’s value to *¨130¨*; however, the more tags are selected, the longer the drone might need to detect and analyze the positions of the markers.

The detected coordinates for X (horizontal) and Y (vertical) are given in a range from 0 to 1000, which means a low value on the left respectively on top and a high value on the right respectively bottom. Also the distance has a value range from 0 to 1000, where 0 means very close and 1000 fare away.

2.7 Using video

For using the drones video, the package “OpenCV2” is used for decoding, preparing and analyzing the images. Using this API to work with the drone’s video-function, it is pretty simple to make yourself familiar with. However, it is still helpful to have some theoretical background knowledge:

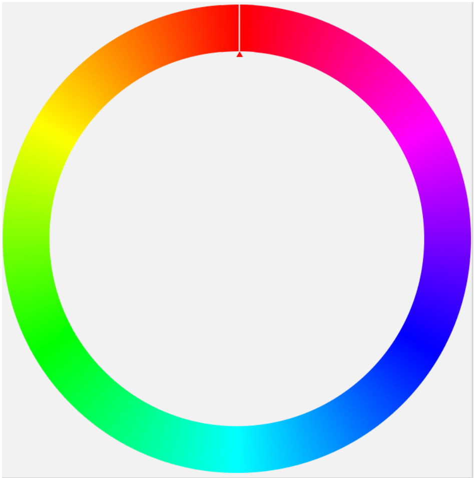
The video-stream of Parrots AR.Drone 2.0 is H.264 or MPEG4 coded (to be exact: MPEG4.10 respectively MPEG4.2).
Both codecs work with “I-frames”, also known as “key-frames”, which store the whole information of an image like a photo or picture, and “P-Frames”, which store just the difference to the preceding frame. I-frames are followed by a certain amount of P-frames. A P-frame always refers to the preceding frame (I-frame or P-frame) and stores only the information that differs from this preceding frame. This might be useful to know as decoding the videostream is pretty complex and needs considerable CPU-usage. For slow(er) computers for which it is impossible to decode every frame in real-time, it is for example not possible to decode every second frame, as P-frames refer to the preceding frame. The result would be a loss of information causing an incorrect and distorted image.



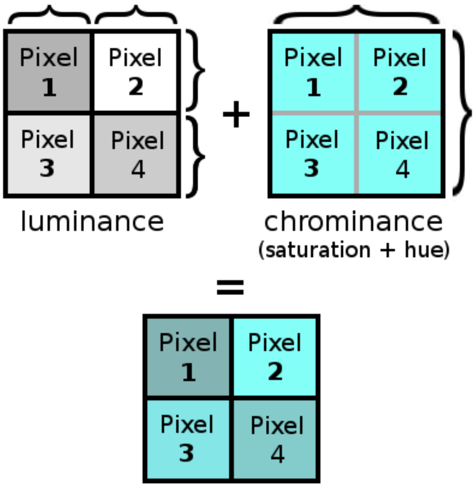
Stylized depiction of a video sequence showing one I-frame, followed by five p-frames

So, decode all or nothing ? Not really, because PS-Drone offers, beside lowering the video-bitrate, the opportunity just to decode the key-frames which are received in a strict period, for up to 95% less CPU-usage.

If you like to examine footage of colored objects, it is also helpful to know that both codecs store their information as progressive 4:2:0 YUV. That means, that every picture is stored as a whole (no two interlaced half pictures) and pixels are represented by luminance, the color's saturation and the color's hue. The color slides from red (0) to green (85) and blue (170) back to (allmost) red (255).
In a square of 2 × 2 pixels, every pixel has its own value for brightness, but all four pixels share the same value for color. That is due to the fact, that the human eye cannot notice colour related differences as good as differences in luminance. Also different shades of blue are not as good distinguishable as different shades of green or red, that is why blue is also stripped down by the compression codecs. These are usual techniques to reduce a video's data stream and not a special limitation of the drone or PS-Drone.



Color wheel



Depiction of four 4:2:0 YUV coded pixels. Each pixel has a value for luminance; four pixels share the same value for chrominance.

The H.264-codec is a pretty recent method to reduce and compact a video-stream. The drone sends the pictures for both cameras in resolutions of 1280 × 720 and 640 × 360 pixels. The MPEG4-codec is older than H.264; it needs more bandwidth, but also less CPU-power to decode and is suggested for slow computers. The drone's resolution for MPEG4-streams is 640 ×

```
##### Suggested clean drone startup sequence #####
import time, sys
import ps_drone             #Imports the PS-Drone-API

drone = ps_drone.Drone()    #Initials the PS-Drone-API
drone.startup()             #Connects to the drone and starts subprocesses

drone.reset()               #Sets drone's LEDs to green when red
while (drone.getBattery()[0]==-1):  time.sleep(0.1)   #Reset completed ?
print¨Battery:¨+str(drone.getBattery()[0])+¨% ¨+str(drone.getBattery()[1])¨
drone.useDemoMode(True)                      #15 basic datasets per second
drone.getNDpackage([¨demo¨,¨vision_detect¨]) #Packets to decoded
time.sleep(0.5)                              #Gives time to fully awake

##### Mainprogram #####
CDC = drone.ConfigDataCount
drone.setConfigAllID()           #Go to multiconfiguration-mode
drone.sdVideo()                  #Choose lower resolution
drone.frontCam()                 #Choose front view
while CDC==drone.ConfigDataCount: time.sleep(0.001) #Wait until it is done
drone.startVideo()               #Start video-function
drone.showVideo()                #Display the video

print¨<space> to toggle front- and groundcamera, any other key to stop¨
IMC =    drone.VideoImageCount   #Number of encoded videoframes
stop =   False
ground = False                   #To toggle front- and groundcamera
    while drone.VideoImageCount==IMC: time.sleep(0.01) #Wait for next image
    IMC = drone.VideoImageCount #Number of encoded videoframes
    key = drone.getKey()
    if key==¨ ¨:
        if ground:          ground = False
        else:               ground = True
        drone.groundVideo(ground) #Toggle between front- and groundcamera.
    elif key and key!=¨ ¨: stop=True
```

Listing 2.9: Sourcecode of sample `firstVideo.py`

The first step to enable video is to switch the drone to the multi-configuration mode, using `setConfigAllID()` as mentioned before. Remember to use the command `setMConfig()` for changing the drone's configurations.
After the video-resolution and the video-codec have been set, using the commands `sdVideo()`/`hdVideo()` and `mp4Video()`, give the drone some time to adjust these settings (you can either just wait or check for changes of `ConfigDataCount`). It will take one to three seconds until the video is fully operable.
Again, it is highly recommended not to alter video-resolution and -codec after the video function has been started. Nevertheless, it is always possible to set or alter any other command any time.

As mentioned before, the AR.Drone 2.0 might have a bug when it comes to setting up the video function. Sometimes the request for a change is set and confirmed by the drone (e.g. switching from front to bottom camera), but nothing happens. Unfortunately, there is no workaround for this.

The usage of the video-images is similar to NavData and ConfigData: Every single decoded video picture is stored as an openCV2-image-object in the variable `VideoData`, its timestamp is stored in `VideoImageTimeStamp` and the time it took to decode in `VideoDecodeTime`.
The variable `VideoReady` shows the status of the video-related processes.

The commands `frontCam()` and `groundCam()` allow to change the streamed camera; the commands `showVideo()` and `hideVideo()` open and hide a window which shows the drone's actual view.

If the used computer is too slow to decode the drones videostream in real-time, you can switch to more economic modes by using the commands `slowVideo()` and `midVideo()`. Both commands determine that only keyframes are decoded, which also means that the frame-rate is decreasing; depending on resolution, used camera and codec, it is between 1 to 2 frames per second.

Due to internal buffers, `slowVideo()` has a higher delay, `midVideo()` needs more time to process, but has the same delay as `fullVideo()`. Using `slowVideo()` reduces the CPU usage for decoding by 92% - 96%, using `midVideo()` by 33% - 82%.

Please note: it is possible that the video initialization can fail for various reasons. It tries to detect and recover the initialization, but it is suggested to start the video-function before the take off.

That is all! For further information and all commands, please see chapter 3, beginning on page 24.

3 PS-Drone-API commands

3.1 Startup

3.1.1 Startup settings

`DroneIP`

IP-address of the drone as a string. Manually editable. (Default: *`¨192.168.1.1¨`*)

`NavDataPort`

Port-number through which the drone sends the NavData-stream, as an integer. Manually editable. (Default: *`5554`*)

`VideoPort`

Port-number through which the drone sends the video-stream, as an integer.
Manually editable. (Default: *`5555`*)

`CMDPort`

Port through which the drone receives commands, as an integer.
Manually editable. (Default: *`5556`*)

`CTLPort`

Port-number through which the drone sends its configuration, as an integer.
Manually editable. (Default: *`5559`*)

3.1.2 *`startup()`*

Connect to the drone.

Usage:	startup()
Return:	None
Note:	After setting drone's IP and Ports, use this command next.
Example:	*`drone.startup()`*

3.2 Calibration

3.2.1 Calibration variables

`selfRotation`

Contains the self-spinning correction value yaw gyrometer in degrees per second, measured by *`getTolerances()`* or manually editable. (Default: *`0.0185`*)

3.2.2 *trim()*

Drone sets the reference to the horizontal plane.

Usage: trim()

Return: None

Note: Drone has to be on the ground.

Example: `drone.trim()`

3.2.3 *mtrim()*

Drone calibrates magnetometer.

Usage: mtrim()

Return: None

Note: Drone has to fly to rotate one time.

Example: `drone.mtrim()`

3.2.4 *mantrim()*

Manual calibration of drone's gyrometers.

Usage: mantrim(theta,phi,yaw)

Return: None

Name:	**Type:**	**Description:**
theta	float	Sets the correction theta-angle (sideward)
phi	float	Sets the correction phi-angle (forward/backward)
yaw	float	Sets the correction yaw-angle (horizontal turn)

Note: It is a function of the drone, but not officially described or supported.

Example: `drone.mantrim(0.321,0.2,0.9113)`

3.2.5 *getSelfRotation()*

Drone measures out the yaw gyrometers self spinning.

Usage: getSelfRotation(time)

Return: Yaw gyro self-spinning correction value in degrees per second.

Name:	**Type:**	**Description:**
time	integer	Time to measure

Note: Drone has to be on the ground, useful for `turnAngle()` or highly accurate measures. The value is stored in `selfRotation`.

Example: `drone.getSelfRotation(10)`

3.3 Movement

3.3.1 Movement variables

speed

The drone's default movement speed, editable by *`setSpeed()`*. (Default: *`0.2`*).

3.3.2 *`takeoff()`*

Drone takes off and enters flight mode.

Usage:	takeoff()
Return:	None
Note:	Necessary before any movement command.
Example:	*`drone.takeoff()`*

3.3.3 *`land()`*

Drone lands and leaves flight mode.

Usage:	land()
Return:	None
Note:	-
Example:	*`drone.land()`*

3.3.4 *`setSpeed()`*

Sets the optional speed of drone's movements.

Usage:	setSpeed(speed)
Return:	speed

Name:	Type:	Description:
speed	float	Speed value from *0.0* to *1.0*; from not active to full thrust.

Note:	Good for basic movement commands.
Example:	*`drone.setSpeed(0.5)`*

3.3.5 *`stop()`*

Drone stops all movements and holds position.

Usage:	stop()
Return:	None
Note:	Use this command to stop. Setting the speed of movement to *0.0* makes the drone glide into the same direction as before and not hold its position.
Example:	*`drone.stop()`*

3.3.6 *Basic movement*

Drone moves or turns to given direction, until it gets the command to change direction.

Usage: moveLeft(optional)
moveRight(optional)
moveForward(optional)
moveBackward(optional)
moveUp(optional)
moveDown(optional)
turnLeft(optional)
turnRight(optional)

Return: None

Name:	Type:	Description:
optional	float	Speed value from *0.0* to *1.0*; from no active movement to full thrust. If empty, the value from *`speed`* will be used.

Note: Very basic movements for first tests, with only one movement at a time. Setting all values to *`0.0`* does not make the drone stop, but glide in the same (horizontal) direction as before. To stop movement, use *`stop()`* instead.

Example: *`drone.moveLeft(0.4)`*

3.3.7 *move()*

Drone moves to all given directions in given speed.

Usage: move(right,forward,up,turn right)

Return: None

Name:	Type:	Description:
right	float	Speed value from *-1.0* to *1.0* from full speed left to full speed right movement, *0.0* for passive.
forward	float	Speed value from *-1.0* to *1.0* from full speed backward to full speed forward movement, *0.0* for passive.
up	float	Speed value from *-1.0* to *1.0* from full speed descent to full speed ascent movement, *0.0* for passive.
turn right	float	Speed value from *-1.0* to *1.0* from full speed left to full speed right rotation, *0.0* for passive.

Note: Setting all speed values to *`0.0`* would not stop movement; use *`stop()`* instead.

Example: *`drone.move(0.0,0.8,-0.1,0)`*

3.3.8 *`relMove()`*

Drone moves, relative to start position and angle, to all given directions in given speed.

Usage: relMove(right,forward,up,turn right)

Return: None

Name:	**Type:**	**Description:**
right	float	Speed value from *-1.0* to *1.0* from full speed left to full speed right movement relative to start position, *0.0* for passive.
forward	float	Speed value from *-1.0* to *1.0* from full speed backward to full speed forward movement relative to start position, *0.0* for passive.
up	float	Speed value from *-1.0* to *1.0* from full speed descent to full speed ascent movement, *0.0* for passive.
turn right	float	Speed value from *-1.0* to *1.0* from full speed left to full speed right rotation, *0.0* for passive.

Note: Use `mtrim()` before using `relMove()`. Setting all speed values to `0.0` would not stop movement; use `stop()` instead.

Example: `drone.relMove(0.0,0.8,-0.1,0)`

3.3.9 *`turnAngle()`*

Drone turns exactly by a given angle.

Usage: turnAngle(degree,maxspeed,optional)

Return: success

Name:	**Type:**	**Description:**
turnangle	float	degree to turn. negative for left, positive for right rotation.
maxspeed	float	Speed value from *0.0* to *1.0* from passive to full speed. If value is *0.0* (passive), value from `speed` will be used instead.
optional	float	Accurateness for rotating to given target-angle. Default for demo-mode is ±0.1° for full-mode ±0.005°.
sucess	bool	`True`, when finished the turn.

Note: Less accurateness means a faster completion of the turn. A self-running gyrometer interference factor, measured by `getTolerances()`, is included for exact turns. If this is not wished, set `selfRotation=0`.
Known bug: this command is not able to perform an exact turn of 180.0°; instead, the drone tries to find its destination angle until the battery is dead and without the possibility to stop the drone neatly.

Example: `drone.turnAngle(-23.811,1)`

3.4 NavData

3.4.1 NavData variables

NavData

Contains the NavData-values as python dictionary. More details in section 4 (starting on page 47) and the source-code of *ps_drone.py*. Not editable.

State

Contains the drone's states as a list. More details in section 4.1 (page 48) and the source-code of *ps_drone.py*. Not editable.

NavDataCount

The Sequential number of the NavData package. Not editable.

NavDataTimeStamp

Time when the NavData package, stored in *NavData*, was decoded. Not editable.

NavDataDecodingTime

Time needed to decode the NavData package, stored in *NavData*. Not editable.

NoNavData

Success-tag of decoding the drone's NavDatas. Will be *False* if a failure occurs; values of *Navdata* will be not actual. Not editable.

3.4.2 *useDemoMode()*

Switch between the NavData demo- and full-mode.

Usage: useDemoMode(optional)

Return: None

Name:	Type:	Description:
optional	boolean	*True*: Use demo-mode or not set. *False*: Use full-mode.

Note: The NavData are sent 200 times per second in full mode and contain, by default, all data. In demo mode, 15 NavData are sent per second and contain, by default, a subset of data.

Example: *drone.useDemoMode(True)*

3.4.3 *useMDemoMode()*

Switch between the NavData demo and full mode in a multi-configuration environment.

Usage: useMDemoMode(optional)

Return: None

Name:	Type:	Description:
optional	boolean	*True*: Use demo-mode or not set. *False*: Use full-mode.

Note: The NavData are sent 200 times per second in full mode and contain, by default, all data. In demo mode, 15 NavData are sent per second and contain, by default, a subset of data.

Example: *drone.useMDemoMode(True)*

3.4.4 *getNDpackage()*

Sets the packages of the NavData sensor measurements to decode.

Usage: getNDpackage([packages])

Return: None

Name:	Type:	Description:
packages	list	A list of packages to decode. See name list in 3.1 below.

Note: Use item `"all"` to get all data.

Example: `drone.getNDpackage(["demo","pwm","altitude","chksum"])`

3.4.5 *addNDpackage()*

Adds packages of the NavData sensor measurements to decode.

Usage: addNDpackage([packages])

Return: None

Name:	Type:	Description:
packages	list	A list of packages to decode. See name list in 3.1 below.

Note: Use item `"all"` to add all data.

Example: `drone.addNDpackage(["demo","pwm","altitude","chksum"])`

3.4.6 *delNDpackage()*

Ignores packages of the NavData sensor measurements to decode.

Usage: delNDpackage([packages])

Return: None

Name:	Type:	Description:
packages	list	A list of packages to decode. See name list in 3.1 below.

Note: Use item `"all"` to ignore all data.

Example: `drone.delNDpackage(["demo","pwm","altitude","chksum"])`

```
"demo", "time", "raw_measures", "phys_measures", "gyros_offsets",
"euler_angles", "references", "trims", "rc_references", "altitude",
"vision_raw", "vision_of", "vision", "vision_perf", "vision_detect",
"games", "trackers_send", "watchdog", "adc_data_frame", "wind_speed",
"pwm", "video_stream", "pressure_raw", "magneto", "kalman_pressure",
"wifi", "hdvideo_stream", "zimmu_3000", "chksum", "all"
```

Listing 3.1: List of available NavData-package-settings

3.4.7 *`reconnectNavData()`*

Reinitializes the NavData communication after a signal loss.

Usage: reconnectNavData()

Return: None

Note: -

Example: *`drone.reconnectNavData()`*

3.5 Configuration

3.5.1 Configuration variables

`ConfigData`

Contains the configuration of the drone as a list. Will be updated after a set of configuration alterations have been transmitted; it will be also updated after the command *`getConfig()`*. More details in section 5 (page 57). Not editable.

`ConfigDataCount`

Sequential number of received copies of the drone's configuration which are stored in *`ConfigData`*. Not editable.

`ConfigDataTimeStamp`

Time when the configuration, stored in *`ConfigData`*, was received. Not editable.

`ConfigSending`

Shows the status of setting configuration. It is *`True`* when in process. Not editable.

`ConfigSessionID`

Contains the drone's session ID for multi-configuration-mode as a string.
Editable by *`setConfigSessionID()`*. (Default: ¨*`03016321`*¨)

`ConfigUserID`

Contains the drone's user ID for multi-configuration-mode as a string.
Editable by *`setConfigUserID()`*. (Default: ¨*`0a100407`*¨)

`ConfigApplicationID`

Contains the drone's application ID for multi-configuration-mode as a string.
Editable by *`setConfigApplicationID()`*. (Default: ¨*`03016321`*¨)

`sendConfigSaveMode`

Indicates that the drone's reconfiguration settings will be done in a slower save-mode when *`True`*. This variable reacts like a command with max 0.1 second delay when changed. Manually editable. (Default: False)

For detailed information about configuration-options , see section 5.1 starting on page 57.

3.5.2 *getConfig()*

Requests drone for a copy of its actual configuration.

Usage: getConfig()

Return: None

Note: No update in real time.

Example: `drone.getConfig()`

3.5.3 *setConfig()*

Changes drone's configuration.

Usage: setConfig(parameter,value)

Return: None

Name:	Type:	Description:
parameter	string	Changes value of parameter as displayed in `ConfigData`.
value	string	Value to set

Note: Settings are not in realtime. `ConfigData` will be updated automatically after all undone settings have been processed.

Example: `drone.setConfig(¨control:altitude_max¨,¨5000¨)`

3.5.4 *setConfigSessionID()*

Sets the session ID for multi-configuration-mode, stores it in `ConfigSessionID` and sends it to the drone.

Usage: setConfigSessionID(id)

Return: id

Name:	Type:	Description:
id	string	A string of eight hexadecimal digits.

Note: Set it before using multi-configuration-mode. Setting is not in real time.

Example: `drone.setConfigSessionID(¨03016321¨)`

3.5.5 *setConfigUserID()*

Sets the session ID for multi-configuration-mode, stores it in `ConfigUserID` and sends it to the drone.

Usage: setConfigUserID(id)

Return: id

Name:	Type:	Description:
id	string	A string of eight hexadecimal digits.

Note: Set it before using multi-configuration-mode. Setting is not in real time.

Example: `drone.setConfigUserID(¨0a100407¨)`

3.5.6 *setConfigApplicationID()*

Sets the session ID for multi-configuration-mode, stores it in `ConfigApplicationID` and sends it to the drone.

Usage: setConfigApplicationID(id)

Return: id

Name:	Type:	Description:
id	string	A string of eight hexadecimal digits.

Note: Set it before using multi-configuration-mode. Setting is not in real time.

Example: `drone.setConfigApplicationID(¨03016321¨)`

3.5.7 *setConfigAllID()*

Sets the session, user and application IDs for multi-configuration-mode of the drone, stored in `ConfigSessionID`, `ConfigUserID` and `ConfigApplicationID`

Usage: setConfigAllID()

Return: None

Note: Settings are not in real time.

Example: `drone.setConfigAllID()`

3.5.8 *sendConfigIDs()*

Identifies the following configuration by sending the session, user and application IDs for the drone's multi-configuration-mode, as stored in `ConfigSessionID`, `ConfigUserID` and `ConfigApplicationID`.

Usage: sendConfigIDs()

Return: None

Note: `setMConfig()` might do what you want.

Example:

```
drone.sendConfigIDs()
drone.setConfigIDs(¨video:video_codec¨,¨131¨)
```

3.5.9 *setMConfig()*

Changes the drone's configuration to multi-configuration-mode.

Usage: setMConfig(parameter,value)

Return: None

Name:	Type:	Description:
parameter	string	Changes value of parameter as displayed in variable `ConfigData`.
value	string	Value of configuration to set.

Note: Settings are not in real time. `ConfigData` will be updated automatically after all settings have been processed. Necessary for most video settings.

Example: `drone.setMConfig(¨video:video_codec¨,¨131¨)`

3.6 Video

3.6.1 Video variables

VideoImage

Contains the actual video-image of the drone as an OpenCV2 image-type, when video is activated. Not editable.

VideoImageCount

Sequential number of decoded video-images which are stored in `VideoImage`. Not editable.

VideoDecodeTimeStamp

Time when the video-image, stored in `VideoImage`, was decoded. Not editable.

VideoDecodeTime

Time needed to decode the video-image, stored in `VideoImage`. Not editable.

VideoReady

Indicates the online status of the video processes. Not editable.

SaveVideo

Indicates, that there is no pre-processing of the drone's video-data-stream. Not settable. (Default: `False`)

3.6.2 *startVideo()*

Activates and processes drone's video.

Usage: startVideo(optional)

Return: None

Name:	Type:	Description:
optional	boolean	If not set or `True`: activates and processes drone's video, `False`: stops drone's video.

Note: Pictures of the video are available by `VideoImage`, start may take a second.

Example: `drone.startVideo()`

3.6.3 *stopVideo()*

Deactivates drone's video.

Usage: stopVideo(optional)

Return: None

Name:	Type:	Description:
optional	boolean	If not set or `True`: stops drone's video, `False`: activates and processes drone's video.

Note: -

Example: `drone.stopVideo()`

3.6.4 *`saveVideo()`*

All video pre-processing will be stopped.

Usage: saveVideo(optional)

Return: None

Name:	**Type:**	**Description:**
optional	boolean	If not set or *`True`*: video save-mode, *`False`*: optimized video mode.

Note: No video pre-processing, useful for unknown non-MPEG-video-codecs. *`slowVideo()`* or *`midVideo()`* will not work in this mode.

Example: *`drone.saveVideo(False)`*

3.6.5 *`fastVideo()`*

Processes the drone's whole video-stream, when video is activated.

Usage: fastVideo(optional)

Return: It is the default video-mode.

Name:	**Type:**	**Description:**
optional	boolean	If not set or *`True`*: normal video-mode, *`False`*: slow video-mode.

Note: Default

Example: *`drone.fastVideo()`*

3.6.6 *`midVideo()`*

Only key-frames of the drone's video-stream will be processed, when video is activated.

Usage: midVideo(optional)

Return: None

Name:	**Type:**	**Description:**
optional	boolean	If not set or *`True`*: slow video-mode with a short delay, *`False`*: fast video-mode.

Note: Depending on used video-codec, resolution and camera, every 15th to 30th picture (see table 3.1 below) will be processed with no delay, but compared to *`slowVideo()`* more performance is needed.

Example: *`drone.midVideo()`*

3.6.7 *`slowVideo()`*

Only key-frames of the drone's video-stream will be processed, when video is activated.

Usage: slowVideo(optional)

Return: None

Name:	**Type:**	**Description:**
optional	boolean	If not set or `True`: slow video-mode, `False`: fast video-mode.

Note: Depending on used video-codec, resolution and camera, every 15th to 30th picture (see table 3.1 below) will be processed with a delay of 2.5 to 5 seconds, but compared to `midVideo()` less performance is needed.

Example: *`drone.slowVideo()`*

Mode	Camera	P-Frames
`sdVideo()`	Front	14
	Ground	14
`hdVideo()`	Front	29
	Ground	19
`mp4Video()`	Front	14
	Ground	14

Table 3.1: Number of P-Frames following after an I-Frame, depending on used mode.

3.6.8 *`frontCam()`*

Switch to drone's front camera.

Usage: frontCam(optional)

Return: None

Name:	**Type:**	**Description:**
optional	boolean	If not set or `True`: Switch to front camera, `False`: Switch to ground camera.

Note: Default, requires multi-configuration-mode, no real-time-setting.

Example: *`drone.frontCam()`*

3.6.9 *`groundCam()`*

Switch to drone's ground camera.

Usage: groundCam(optional)

Return: None

Name:	**Type:**	**Description:**
optional	boolean	If not set or `True`: Switch to ground camera, `False`: Switch to front camera.

Note: Requires multi-configuration-mode, no real-time-setting.

Example: *`drone.groundCam()`*

3.6.10 *`sdVideo()`*

Sets the drone's video stream to H.264 encoded, with an image resolution of 640 × 360.

Usage: sdVideo(optional)

Return: None

Name:	**Type:**	**Description:**
optional	boolean	If not set or *`True`*: Drone sends H.264-video-stream with 640×360, *`False`*: Drone sends HD H.264-video-stream.

Note: Default, requires multi-configuration-mode, no real-time-setting.

Example: *`drone.sdVideo()`*

3.6.11 *`hdVideo()`*

Sets the drone's video stream to H.264 encoded, with an image resolution of 1280 × 720.

Usage: hdVideo(optional)

Return: None

Name:	**Type:**	**Description:**
optional	boolean	If not set or *`True`*: Drone sends H.264-video with 1280 × 720, *`False`*: Drone sends SD H.264-video-stream.

Note: Requires multi-configuration-mode, no real-time-setting.

Example: *`drone.hdVideo()`*

3.6.12 *`mp4Video()`*

Sets the drone's video stream to MPEG4.2 encoded, with an image resolution of 640 × 368.

Usage: mp4Video(optional)

Return: None

Name:	**Type:**	**Description:**
optional	boolean	If not set or *`True`*: Drone sends MPEG4-video-stream with 640 × 368, *`False`*: Drone sends SD H.264-video-stream.

Note: Requires multi-configuration-mode, no real-time-setting.

Example: *`drone.mp4Video()`*

3.6.13 *showVideo()*

Displays drone's video in a window.

Usage: showVideo(optional)

Return: None

Name:	Type:	Description:
optional	boolean	If not set or `True`: starts displaying drone's video, `False`: hides drone's video.

Note: Do not change resolution or codec when this function is enabled.

Example: `drone.showVideo()`

3.6.14 *hideVideo()*

Hides drone's video.

Usage: hideVideo(optional)

Return: None

Name:	Type:	Description:
optional	boolean	If not set or `True`: hides drone's video, `False`: starts displaying drone's video.

Note: -

Example: `drone.hideVideo()`

3.6.15 *videoFPS()*

Changes the frame rate of the video.

Usage: videoFPS(fps)

Return: None

Name:	Type:	Description:
fps	integer	Frames per second of drone's video. Values: `1 - 60`.

Note: Requires multi-configuration-mode, no real-time-setting.

Example: `drone.videoFPS(15)`

3.6.16 *videoBitrate()*

Changes the bitrate of the video stream.

Usage: videoBitrate(br)

Return: None

Name:	Type:	Description:
br	integer	Kilobit per second for drone's video encoding. Values: `250 - 20000`.

Note: Requires multi-configuration-mode, no real-time-setting.

Example: `drone.videoBitrate(4000)`

3.7 Convenient Commands

3.7.1 *getBattery()*

Gets battery information of the drone.

Usage: getBattery()

Return: (batValue,batStatus)

Name:	**Type:**	**Description:**
batValue	integer	Battery charge level in percent.
batValue	string	Drone's battery status, ¨OK¨ or ¨empty¨.

Note: -

Example: *print ¨Battery: ¨+str(drone.getBattery()[0])+¨% ¨ +str(drone.getBattery()[1])*

3.7.2 *getKey()*

Gets the character of a pressed key.

Usage: getKey()

Return: key

Name:	**Type:**	**Description:**
key	string	Character of a pressed key.

Note: -

Example: *drone.getKey()*

3.7.3 *angleDiff()*

Gets the difference between two measured angles.

Usage: angleDiff(base,degrees)

Return: difference

Name:	**Type:**	**Description:**
base	float	First angle in *-180.0* to *180.0* degrees.
degrees	float	Second angle in *-180.0* to *180.0* degrees.
difference	float	The smallest difference between first and second angle.

Note: -

Example: *drone.angleDiff(-170,170)*

3.7.4 *printDefault()*

Prints text in default color.

Usage: printDefault(optional)

Return: None

Name:	Type:	Description:
optional	string	Prints the optional string in default color, otherwise all following text will print in default color.

Note: -

Example: `drone.printDefault(¨All normal¨)`

3.7.5 *printRed()*

Prints text in red color.

Usage: printRed(optional)

Return: None

Name:	Type:	Description:
optional	string	Prints the optional string in red color, otherwise all following.

Note: You may use `printDefault()` to disable red text.

Example: `drone.printRed(¨Error¨)`

3.7.6 *printGreen()*

Prints text in green color.

Usage: printGreen(optional)

Return: None

Name:	Type:	Description:
optional	string	Prints the optional string in green color, otherwise all following.

Note: You may use `printDefault()` to disable green text.

Example: `drone.printGreen(¨OK¨)`

3.7.7 *printYellow()*

Prints text in yellow color.

Usage: printYellow(optional)

Return: None

Name:	Type:	Description:
optional	string	Prints the optional string in yellow color, otherwise all following.

Note: You may use `printDefault()` to disable yellow text.

Example: `drone.printYellow(¨Warning !¨)`

3.7.8 *printBlue()*

Prints text in blue color.

Usage: printBlue(optional)

Return: None

Name:	Type:	Description:
optional	string	Prints the optional string in blue color, otherwise all following.

Note: You may use *`printDefault()`* to disable blue text.

Example: *`drone.printBlue(¨Notice¨)`*

3.7.9 *printPurple()*

Prints text in purple color.

Usage: printPurple(optional)

Return: None

Name:	Type:	Description:
optional	string	Prints the optional string in purple color, otherwise all following.

Note: You may use *`printDefault()`* to disable purple text.

Example: *`drone.printPurple(¨Header¨)`*

3.7.10 *printLineUp()*

Following printout will appear one line up.

Usage: printLineUp()

Return: None

Note: -

Example: *`drone.printLineUp()`*

3.7.11 *doggyHop()*

Drone hops like a happy dog.

Usage: doggyHop()

Return: None

Note: -

Example: *`drone.doggyHop()`*

3.7.12 *doggyNod()*

Drone nods.

Usage: doggyNod()

Return: None

Note: -

Example: `drone.doggyNod()`

3.7.13 *doggyWag()*

Drone wags like a happy dog.

Usage: doggyWag()

Return: None

Note: -

Example: `drone.doggyWag()`

3.8 Misc commands

3.8.1 Misc variables

Version
Shows the version of the PS-Drone-API. Not editable.

startTime
Stores the PS-Drone-API's starting-time. Not editable.

showCommands
If set, most commands from PS-Drone-API to the drone and communication between the processes will be displayed. This variable reacts like a command with max 0.1 second delay when changed. Manually editable. (Default: `False`)

debug
If set, debug messages will be displayed. This variable reacts like a command with max 0.1 second delay when changed. Manually editable. (Default: `False`)

valueCorrection
Enables the correction of most values, when out of range, if set. (Default: `True`)

3.8.2 *reset()*

Initiates a soft reset of the drone.

Usage: reset()

Return: None

Note: -

Example: `drone.reset()`

3.8.3 *thrust()*

Controls the motor thrust directly.

Usage: thrust(front left, front right, rear left, rear right)

Return: None

Name:	Type:	Description:
front_left	int	Value from *0* to *255* for the front left motor thrust.
front_right	int	Value from *0* to *255* for the front right motor thrust.
rear_left	int	Value from *0* to *255* for the rear left motor thrust.
rear_right	int	Value from *0* to *255* for the rear right motor thrust.

Note: Overrides the control of the drone's system.
The order of motors differs from their values in `"pwm"`-NavData-package.

Example: `drone.thrust(25,25,25,25)`

3.8.4 *pwm()*

Controls the motor thrust directly.

Usage: thrust(front left, front right, rear left, rear right)

Return: None

Name:	Type:	Description:
front_left	int	Value from *0* to *511* for the front left motor thrust.
front_right	int	Value from *0* to *511* for the front right motor thrust.
rear_left	int	Value from *0* to *511* for the rear left motor thrust.
rear_right	int	Value from *0* to *511* for the rear right motor thrust.

Note: Deprecated ! Overrides the control of the drone's system.
The order of motors differs from their values in `"pwm"`-NavData-package.

Example: `drone.pwm(50,50,50,50)`

3.8.5 *shutdown()*

Lands and disconnects from drone, determines PS-Drone-API.

Usage: shutdown()

Return: None

Note: Will run as last command, when the user's-program ended, as default.

Example: `drone.shutdown()`

3.8.6 *anim()*

Drone does pre-set movement.

Usage: anim(movement, duration)

Return: None

Name:	Type:	Description:
movement	int	Number of animation, see list below.
duration	int	Duration of the animation

Note: -

Example: `drone.anim(0,1)`

anim	discription
0	Short tipping about 30° to the left
1	Short tipping about 30° to the right
2	Short tipping about 30° front down
3	Short tipping about 30° front up
4	Slide to the left
5	Slide to the right
6	Spin clockwise
7	Spin clockwise and goes down
8	Yaw shake
9	Dance by rotating
10	Dance left/right
11	Dance forward/backward
12	Dance upward/downward
13	Tipping right then left. Tipping front up then down
14	Tipping left then right. Tipping front down then up
15	Double tipping left, then right. Double tipping front down, then up
16	Flip ahead
17	Flip backward
18	Flip left
19	Flip right

Table 3.2: Possible options for `anim()` and drone's behaviour.

3.8.7 *`led()`*

Drone shows pre-set sequences with the LEDs at the end of the arms.

Usage: led(animation, frequency, duration)

Return: None

Name:	**Type:**	**Description:**
animation	integer	Number of animation, see list below.
frequency	float	Speed of animation
duration	integer	Duration of animation

Note: -

Example: *`drone.led(0,1.5,1)`*

anim.	description
0	All LEDs are red, then all LEDs are green
1	All LEDs are green, then all LEDs are off
2	All LEDs are red, then all LEDs are off
3	All LEDs are orange, then all LEDs are off
4	All LEDs flash fast green/red/off
5	Front LEDs alternate fast yellow/off, rear LEDs are red
6	Front LEDs are green, read LEDs are red
7	All LEDs are red
8	All LEDs are green
9	Front left LED is red, all other are off. The light moves clockwise.
10	All LEDs are off
11	Left LEDs are off, right: rear LED is red, then rear LED is off and front LED is yellow. Then all LEDs are off
12	Right LEDs are off, left: rear LED is red, then rear LED is off and front LED is yellow. Then all LEDs are off
13	Rear LEDs are red, then are off and front LEDs are yellow. All LEDs are off
14	Front left LED is green, all other LEDs are red
15	Front right LED is green, all other LEDs are red
16	Rear right LED is green, all other LEDs are red
17	Rear left LED is green, all other LEDs are red
18	Left LEDs are green, right LEDs are red
19	Left LEDs are red, right LEDs are green
20	Front LEDs are green, rear LEDs are red, then all LEDs are off

Table 3.3: Possible options for `led()` and drone's behaviour.

3.8.8 *aflight()*

Makes the drone fly around and follow 2D tags the camera can detect.

Usage: aflight(flag)

Return: None

Name:	Type:	Description:
flag	boolean	`True`: start flight, `True`: stop flight

Note: Drone function, might be obsolete.

Example: `drone.aflight(True)`

3.8.9 *at()*

Sends a command and its parameters to the drone.

Usage: at(command,[parameters])

Return: None

Name:	Type:	Description:
command	string	Drone command.
parameters	various	Command's parameter(s)

Note: For valid commands and parameters check AR.Drone 2.0 developer guide.

Example: `drone.at(¨PCMD¨, [0,0.0,0.0,0.0,0.0])`

4 NavData packages

NavData are sent as blocks, including the sensor-measurements and status information; each block is divided into a bunch of 28 packages which contain a specific set of values. The names of the packages in this API remain the same as in Parrot's SDK.

```
"demo", "time", "raw_measures", "phys_measures", "gyros_offsets",
"euler_angles", "references", "trims", "rc_references", "pwm",
"altitude", "vision_raw", "vision_of", "vision", "vision_perf",
"trackers_send", "vision_detect", "watchdog", "adc_data_frame",
"video_stream", "games", "pressure_raw", "magneto", "wind_speed",
"kalman_pressure", "hdvideo_stream", "wifi", "zimmu_3000", "chksum"
```

Listing 4.1: List of available NavData-packages

The drone provides two modes for sending its NavData, a ¨demo¨- and a ¨full¨-mode. Depending on the mode, 15 or 200 NavData are sent per second.

The availability of the NavData-packages also differs depending on whether the demo-mode is enabled or disabled.
With enabled demo-mode, by default, only the packages `"demo"`, `"vision_detect"` and `"chksum"` are available 15 times a second, but most of the time that is enough. With disabled demo-mode, by default, all 28 packages are sent 200 times per second. There are also state-tags available; however, like most other packages, they are not very important and are always sent with each of NavData's header.

4.1 *State*

The following entries can be found at the APIs *State*-variable.

No	Name	0:	1:
[0]	Fly mask	Drone landed	Drone is flying
[1]	Video mask	Video disabled	Video enabled
[2]	Vision mask	Vision disabled	Vision enabled
[3]	Control algo	Euler angles control	Angular speed control
[4]	Altitude control	Altitude control inactive	Altitude control active
[5]	User feedback	Start button not pressed	Start button pressed
[6]	Control command ACK	None	received
[7]	Camera mask	Camera not ready	Camera ready
[8]	Travelling mask	disabled	enabled
[9]	USB key	USB flash drive is not ready	USB flash drive is ready
[10]	NavData demo	All NavData	NavData demo
[11]	Navdata bootstrap	Options sent	No NavData options sent
[12]	Motors status	OK	Problem
[13]	Communication lost	Com is ok	Com problem
[14]	Software fault	OK	Software fault detected
[15]	Batterystatus	OK	too low
[16]	User emergency landing	User EL is OFF	User EL is ON
[17]	Timer elapsed	Not elapsed	Elapsed
[18]	Magnetometer calib	No calibration needed	Calibration needed
[19]	Angles	OK	Out of range
[20]	Wind mask	OK	Too much wind
[21]	Ultrasonic sensor	OK	Deaf
[22]	Cutout system	Not detected	Detected
[23]	PIC Version number	Bad version number	Version number is OK
[24]	ATCodec thread	OFF	ON

4.2 *NavData*

Most of the packages are not well documented. The following sections contain all information found, mostly in crude form. The entries' names remain the same as in Parrot's AR.Drone 2.0 SDK. Parrot's AR.Drone 2.0 SDK packages' names are the these names, covert in ¨NAVDATA_¨ and ¨_TAG¨, e.g. ¨NAVDATA_DEMO_TAG¨.

4.2.1 *¨demo¨*

Pos	Datatype	Name	Note
[0][0]	bool	default	
[0][1]	bool	init	
[0][2]	bool	landed	Landed, or flight-mode not initialled
[0][3]	bool	flying	Initialled flight-mode
[0][4]	bool	hovering	Better name would be ¨landing¨
[0][5]	bool	test	
[0][6]	bool	trans_takeoff	
[0][7]	bool	trans_gofix	
[0][8]	bool	trans_landing	
[0][9]	bool	trans_looping	
[0][10]	bool	trans_no_vision	
[0][11]	bool	num_state	
[1]	uint32	vbat_flying_percentage	Charge of battery in percent
[2][0]	float	theta	Pitch in degrees
[2][1]	float	phi	Roll in degrees
[2][2]	float	psi	Yaw in degrees
[3]	float	altitude	Altitude in centimetres
[4][0..2]	float	vx/vy/vz	Estimated speed in X/Y/Z in mm/s
[5]	uint32	num_frames	Streamed frame index, don't use !
[6][0..8]	matrix33	detection_camera_rot	Camera params computed by detection
[7][0..2]	vector3	detection_camera_trans	Deprecated ! Don't use !
[8]	uint32	detection_	

4.2.4 ¨*magneto*¨

Pos	Datatype	Name	Note
[0][0..2]	int16	mx/my/mz	Magnetometer measurements [xyz]
[1][0..2]	float	magneto_raw	Magneto in the body frame [mG]
[2][0..2]	float	magneto_rectified	
[3][0..2]	float	magneto_offset	
[4]	float	heading_unwrapped	
[5]	float	heading_gyro_unwrapped	
[6]	float	heading_fusion_unwrapped	
[7]	uint8	magneto_calibration_ok	
[8]	uint32	magneto_state	
[9]	float	magneto_radius	
[10]	float	error_mean	
[11]	float	error_var	

4.2.5 ¨*altitude*¨

Pos	Datatype	Name	Note
[0]	int32	altitude_vision	[mm]
[1]	float	altitude_vz	[mm/2]
[2]	int32	altitude_ref	[mm]
[3]	int32	altitude_raw	[mm]
[4]	float	obs_accZ	Observer AccZ [m/s^2]
[5]	float	obs_alt	Observer altitude US [m]
[6][0..2]	vector3	obs_x	
[7]	uint32	obs_state	Observer state
[8][0..1]	Vector2	est_vb	
[9]	uint32	est_state	Observer flight state

4.2.6 ¨*pressure_raw*¨

Pos	Datatype	Name	Note
[0]	int32	up	
[1]	int16	ut	
[2]	int32	temperature_meas	
[3]	int32	pression_meas	

4.2.7 ¨*wind_speed*¨

Pos	Datatype	Name	Note
[0]	float	wind_speed	
[1]	float	wind_angle	
[2][0]	float	wind_compensation_theta	
[2][1]	float	wind_compensation_phi	
[3][0..5]	float	state_x[6]	
[4][0..2]	float	magneto_debug[3]	

4.2.8 ¨*kalman_pressure*¨

Pos	Datatype	Name	Note
[0]	float	offset_pressure	
[1]	float	est_z	Estimated hight
[2]	float	est_zdot	
[3]	float	est_bias_PWM	
[4]	float	est_biais_pression	
[5]	float	offset_US	
[6]	float	prediction_US	
[7]	float	cov_alt	
[8]	float	cov_PWM	
[9]	float	cov_vitesse	
[10]	bool	bool_effet_sol	
[11]	float	somme_inno	
[12]	bool	flag_rejet_US	
[13]	float	u_multisinus	
[14]	float	gaz_altitude	
[15]	bool	flag_multisinus	
[16]	bool	flag_multisinus_debut	

4.2.9 ¨*zimmu_3000*¨

Pos	Datatype	Name	Note
[0]	int32	vzimmu	
[1]	float	vzfind	

4.2.10 ¨*raw_measures*¨

Pos	Datatype	Name	Note
[0][0..2]	uint16	raw_accs[xyz]	filtered accelerometer-data [LSB]
[1][0..2]	int16	raw_gyros[xyz]	filtered gyrometer-data [LSB]
[2][0..2]	int16	raw_gyros_110[xyz]	gyrometers x/y 110 deg/s [LSB]
[3]	uint32	vbat_raw	battery voltage [mV]
[4]	uint16	us_debut_echo	
[5]	uint16	us_fin_echo	
[6]	uint16	us_association_echo	
[7]	uint16	us_distance_echo	
[8]	uint16	us_courbe_temps	
[9]	uint16	us_courbe_valeur	
[10]	uint16	us_courbe_ref	
[11]	uint16	flag_echo_ini	
[12]	uint16	nb_echo	
[13]	uint32	sum_echo	(just lower 16Bit (higher 16Bit=tags?))
[14]	uint32	alt_temp_raw	in millimetre (just lower 16Bit)
[15]	uint16	gradient	

4.2.11 ¨phys_measures¨

Pos	Datatype	Name	Note
[0]	float	accs_temp	
[1]	uint16	gyro_temp	
[2][0..2]	float	phys_accs[xyz]	
[3][0..2]	float	phys_gyros[xyz]	
[4]	uint32	alim3V3	3.3volt alim
[5]	uint32	vrefEpson	Ref volt Epson gyro
[6]	uint32	vrefIDG	Ref volt IDG gyro

4.2.12 ¨references¨

Pos	Datatype	Name	Note
[0][0]	int32	ref_theta	Theta ref embedded [milli-deg]
[0][1]	int32	ref_phi	Phi ref embedded [milli-deg]
[0][2]	int32	ref_psi	Psi ref embedded [milli-deg]
[1][0]	int32	ref_theta_I	Theta ref int [milli-deg]
[1][1]	int32	ref_phi_I	Phi ref int [milli-deg]]
[2][0]	int32	ref_pitch	Pitch ref embedded [milli-deg]
[2][1]	int32	ref_roll	Roll ref embedded [milli-deg]
[2][2]	int32	ref_yaw	Yaw ref embedded [milli-deg/s]
[3][0]	float	vx_ref	Vx Ref [mm / s]
[3][1]	float	vy_ref	Vy Ref [mm / s]
[4][0]	float	theta_mod	Theta modele [radian]
[4][1]	float	phi_mod	Phi modele [radian]
[5][0]	float	k_v_x	
[5][1]	float	k_v_y	
[6]	uint32	k_mode	
[7][0]	float	ui_time	
[7][1]	float	ui_theta	
[7][2]	float	ui_phi	
[7][3]	float	ui_psi	
[7][4]	float	ui_psi_accuracy	
[7][5]	int32	ui_seq	

4.2.13 ¨rc_references¨

Pos	Datatype	Name	Note
[0]	int32	rc_ref_pitch	Pitch rc embedded
[1]	int32	rc_ref_roll	Roll rc embedded
[2]	int32	rc_ref_yaw	Yaw rc embedded
[3]	int32	rc_ref_gaz	Gaz rc embedded
[4]	int32	rc_ref_ag	Ag rc embedded

4.2.14 ¨gyros_offsets¨

Pos	Datatype	Name	Note
[0][0..2]	float	offset_g[xyz]	[deg/s]

4.2.15 ¨euler_angles¨

Pos	Datatype	Name	Note
[0]	float	theta_a	head / back
[1]	float	phi_a	sides

4.2.16 ¨watchdog¨

Pos	Datatype	Name	Note
-	uint32	watchdog	Watchdog controll

4.2.17 ¨trims¨

Pos	Datatype	Name	Note
[0]	float	angular_rates_trim	
[1]	float	euler_angles_trim_theta	[milli-deg]
[2]	float	euler_angles_trim_phi	[milli-deg]

4.2.18 ¨pwm¨

Pos	Datatype	Name	Note
[0][0..3]	uint8	motor[1234]	[Pulse-width mod]
[1][0..3]	uint8	sat_motor[1234]	[Pulse-width mod]
[2]	float	gaz_feed_forward	[Pulse-width mod]
[3]	float	gaz_altitud	[mm/s]
[4]	float	altitude_integral	[mm/s]
[5]	float	vz_ref	[Pulse-width mod]
[6][0]	int32	u_pitch	[Pulse-width mod]
[6][1]	int32	u_roll	[Pulse-width mod]
[6][2]	int32	u_yaw	[Pulse-width mod]
[7]	float	yaw_u_I	[Pulse-width mod]
[8][0]	int32	u_pitch_planif	[Pulse-width mod]
[8][1]	int32	u_roll_planif	[Pulse-width mod]
[8][2]	int32	u_yaw_planif	[Pulse-width mod]
[8][3]	float	u_gaz_planif	[Pulse-width mod]
[9][0..3]	uint16	current_motor[1234]	[mA]
[10]	float	altitude_prop	[Pulse-width mod]
[11]	float	altitude_der	[Pulse-width mod]

4.2.19 ¨`vision`¨

Pos	Datatype	Name	Note
[0]	uint32	vision_state	
[1]	int32	vision_misc	
[2]	float	vision_phi_trim	
[3]	float	vision_phi_ref_prop	
[4]	float	vision_theta_trim	
[5]	float	vision_theta_ref_prop	
[6]	int32	new_raw_picture	
[7][0..2]	float	theta/phi/psi_capture	
[8]	int32	altitude_capture	
[9]	float	time_capture	
[10][0..2]	float	velocities[xyz]	X-/Y-/Z-velocity
[11][0..2]	float	delta_phi/theta/psi	
[12]	uint32	gold_defined	
[13]	uint32	gold_reset	
[14][0]	float	gold_x	
[14][1]	float	gold_y	

4.2.20 ¨`vision_stream`¨

Pos	Datatype	Name	Note
[0]	uint8	quant	Quantizer reference used to encode
[1]	uint32	frame_size	Frame size in bytes
[2]	uint32	frame_number	Frame index
[3]	uint32	atcmd_ref_seq	Atmcd ref sequence number
[4]	uint32	atcmd_mean_ref_gap	Mean time between two consecutive atcmd_ref [ms]
[5]	float	atcmd_var_ref_gap	
[6]	uint32	atcmd_ref_quality	Estimator of atcmd link quality
[7]	uint32	out_bitrate	Measured out throughput from the video TCP-socket
[8]	uint32	desired_bitrate	Size of last frame generated by the video encoder
[9][0..4]	int32	data	Misc temporary data
[10]	uint32	tcp_queue_level	Queue usage
[11]	uint32	fifo_queue_level	Queue usage

4.2.21 ¨`vision_of`¨

Pos	Datatype	Name	Note
[0][0..4]	float	of_dx	
[1][0..4]	float	of_dy	

4.2.22 ¨vision_raw¨

Pos	Datatype	Name	Note
[0..2]	float	vision_tx_raw[xyz]	

4.2.23 ¨vision_detect¨

Pos	Datatype	Name	Note
[0]	uint32	nb_detected	Number of found markers
[1][0..3]	uint32	type[4]	Type of detected marker
[2][0..3]	uint32	xc[4]	X-pos of marker (0-1000), 0=left
[3][0..3]	uint32	yc[4]	Y-pos of marker (0-1000), 0=top
[4][0..3]	uint32	width[4]	Optical width of marker
[5][0..3]	uint32	height[4]	Optical height of marker
[6][0..3]	uint32	dist[4]	Distance of marker (0-1000), 0=near
[7][0..3]	float	orientation_angle[4]	Orientation of marker [deg]
[8][0..3]	matrix33	rotation[4]	
[9][0..3]	vector3	rotation[4]	
[10][0..3]	uint32	camera_source[4]	

4.2.24 ¨vision_perf¨

Pos	Datatype	Name	Note
[0]	float	time_szo	
[1]	float	time_corners	
[2]	float	time_compute	
[3]	float	time_tracking	
[4]	float	time_trans	
[5]	float	time_update	
[6][0..19]	float	time_custom[20]	

4.2.25 ¨hdvideo_stream¨

Pos	Datatype	Name	Note
[0]	float	hdvideo_state	
[1]	float	storage_fifo_nb_packets	
[2]	float	storage_fifo_size	
[3]	float	usbkey_size	USB flash drive in kb (no key=0)
[4]	float	usbkey_freespace	USB flash drive in kb (no key=0)
[5]	float	frame_number	PaVE field of the frame encoder started
[6]	float	usbkey_remaining_time	[sec]

4.2.26 ¨games¨

Pos	Datatype	Name	Note
[0]	uint32	double_tap_counter	
[1]	uint32	finish_line_counter	

4.2.27 ¨*trackers_send*¨

Pos	Datatype	Name	Note
[0..29]	int32	locked[30]	
[0..29][0..1]	int32	point[x[30],y[30]]	

4.2.28 ¨*adc_data_frame*¨

Pos	Datatype	Name	Note
[0]	uint32	version	
[0][0..31]	uint8	data_frame[32]	

4.2.29 ¨*chksum*¨

Pos	Datatype	Name	Note
[0]	uint32	chksum	Transmitted checksum
[1]	uint32		Checksums match

5 Configuration entries

5.1 General

general:num_version_config *Std: read only*

Configuration subsystem's version.

general:num_version_mb *Std: read only*

Drone's mainboard hardware-version.

general:num_version_soft *Std: read only*

Drone's firmware-version.

general:drone_serial *Std: read only*

Drone's serial number.

general:soft_build_date *Std: read only*

Drone's firmware compilations date.

general:motor1_soft *Std: read only*

Software version of drone's motor subsystem 1.
Also available for motor subsystem 2, 3 and 4.

general:motor1_hard *Std: read only*

Hardware version of drone's motor subsystem 1.
Also available for motor subsystem 2, 3 and 4.

general:motor1_supplier *Std: read only*

Supplier code of drone's motor subsystem 1.
Also available for motor subsystem 2, 3 and 4.

general:ardrone_name *Std: read/write*

Drone's name for AR-game development.
Note: The name is not related to WiFi-SSID.

general:flying_time *Std: read only*

Time (in seconds) the drone spent in a flying state in its whole lifetime.

general:navdata_demo *Std: read/write*

Tag that indicates the drone's send mode for NavData.
`TRUE` means that NavData are sent in demo mode, `FALSE` stands for full send mode. See section 4 on page 47 for further details.
This setting can also be done by the command `useDemoMode()` and `useMDemoMode()`, described in section 3.4.1 on page 29.

general:navdata_options *App: read/write*

Enabled NavData-packages sent by the drone. The basic demo-mode-packages `state`, `demo`, `vision_detect` and `chksum` are always sent and cannot be disabled.

`demo` :	1	`vision_perf` :	16384
`time` :	2	`trackers_send` :	32768
`raw_measures` :	4	`vision_detect` :	65536
`phys_measures` :	8	`watchdog` :	131072
`gyros_offsets` :	16	`adc_data_frame` :	262144
`euler_angles` :	32	`video_stream` :	524288
`references` :	64	`games` :	1048576
`trims` :	128	`pressure_raw` :	2097152
`rc_references` :	256	`magneto` :	4194304
`pwm` :	512	`wind_speed` :	8388608
`altitude` :	1024	`kalman_pressure` :	16777216
`vision_raw` :	2048	`hdvideo_stream` :	33554432
`vision_of` :	4096	`wifi` :	67108864
`vision` :	8192	`zimmu_3000` :	134217728

Table 5.1: Values to set NavData-package to be sent

Add values for packages you want to get, e.g.:
`demo` + `time` + `trims` + `vision_detect` = 65667.
Default packages in demo-mode and in full-mode: 65537 and 268435455.

general:vbat_min *Std: read only*

Minimum battery charge before drone lands automatically.

general:vision_enable *Std: read/write*

Reserved for future use, value has to be `TRUE` *to prevent unexpected behaviour.*
Note: Not related to tag detection.

general:localtime *Std: read only*

No description available

general:video_enable *Std: read/write*

Reserved for future use, value has to be `TRUE` *to prevent unexpected behaviour.*

general:com_watchdog *Std: read/write*

Shows the time (in seconds) the drone accepts not to receive any command from a client before it will cut the connection. Default: *2*
Officially, the drone should also stop its moving and hover on its position.
Note: Only important for connection-losses as the PS-Drone-API sends keep-alive commands to prevent the drone becoming passive.

5.2 Control

control:altitude_max *Std: read/write*

Drone's maximum altitude in millimetres. The altitude is measured by the pressure-sensor and has no limitation.

control:altitude_min *Std: read/write*

Drone's minimum altitude in millimetres. Might cause problems regarding stability when modified.

control:flight_without_shell *Std: read/write*

Indicates the shell the drone expects to be covered. When set to flying with outdoor shell by change to `True`, several internal optimizations regarding flight behaviour will be done.
Default: `False` / indoor-shell.

control:autonomous_flight *Std: read/write*

Indicates autonomous flight-mode. By default disabled (controlled by client), can cause unexpected behaviour when set `True`.
Deprecated and not longer maintained by Parrot.

control:accs_offset *Std: read only*

Accelerometers offset. *For Parrot's internal debugging.*

control:accs_gains *Std: read only*

Accelerometers gains. *For Parrot's internal debugging.*

control:gyros_offset *Std: read only*

Gyrometers offset. *For Parrot's internal debugging.*

control:gyros_gains *Std: read only*

Gyrometers gains. *For Parrot's internal debugging.*

control:gyros110_offset *Std: read only*

For Parrot's internal debugging.

control:gyros110_gains *Std: read only*

For Parrot's internal debugging.

control:magneto_offset *Std: read only*

For Parrot's internal debugging.

control:magneto_radius *Std: read only*

For Parrot's internal debugging.

control:gyro_offset_thr_x *Std: read only*

For Parrot's internal debugging. Also available for Y- and Z-axis.

control:pwm_ref_gyros *Std: read only*

For Parrot's internal debugging.

control:osctun_value *Std: read only*

For Parrot's internal debugging.

control:osctun_test *Std: read only*

For Parrot's internal debugging.

control:flying_mode *Sess: read/write*

Displays the current flight mode. There are three flight modes available by setting a value:

0	Legacy mode, the drone is controlled by a client (Default)
1	Semi-autonomous mode, the drone hovers above a roundel-tag (page 75)
2	Semi-autonomous mode, the drone hovers above an oriented-black-and-white-roundel-tag and faces in tags direction (page 77).

Table 5.2: Settings for different flying-modes.

Note: You have to choose the tag you use by editing `detect:detect_type`, described on page 64.

control:hovering_range *Sess: read/write*

Drone's maximum allowed distance to an oriented-roundel in millimetres. Only in use when the drone is in a semi-autonomous-flight-mode, set by `control:flying_mode`.

control:manual_trim *Usr: read/write*

Tag that indicates that the drone uses manual trims.
`FALSE` stands for automated trims, `TRUE` means activated manual trims.
Note: Parrot suggests not to use manual trims.

control:flight_anim *Std: read/write*

When set, drone flies a pre-set movement. First value sets the type of movement, second value sets the duration.

anim	discription
0	Short tipping about 30° to the left
1	Short tipping about 30° to the right
2	Short tipping about 30° front down
3	Short tipping about 30° front up
4	Slide to the left
5	Slide to the right
6	Spin clockwise
7	Spin clockwise and goes down
8	Yaw shake
9	Dance by rotating
10	Dance left/right
11	Dance forward/backward
12	Dance upward/downward
13	Tipping right then left. Tipping front up then down
14	Tipping left then right. Tipping front down then up
15	Double tipping left, then right. Double tipping front down, then up
16	Flip ahead
17	Flip backward
18	Flip left
19	Flip right

Table 5.3: Possible first values for `control:flight_anim` and drone's behaviour.

The setting is also implemented by PS-Drone-API-commands `anim()`, described in section 3.8.5 on page 43.

control:control_level *App: read/write*

Shows how the drone will react to user's movement-commands. Normally, the drone turns on a horizontal axis and is always in a stable condition. In race-mode, the drone moves more dynamically and may "lean into the bend" while rotating.

1	Normal movement, only turning
3	Race-mode, lean into the bend

Table 5.4: Settings for movement behaviour control.

Other values could cause unexpected behaviour of the drone.

control:outdoor *Std: read/write*

Indicates which surrounding the movement settings are optimized for. When set to outdoor-mode by change to `True`, wind estimation will be enabled. Furthermore, values for the drone's behaviour will be taken from `control:outdoor_control_yaw`, `control:outdoor_euler_angle_max` and `control:outdoor_control_vz_max`, instead of the values from `control:indoor_control_yaw`, `control:indoor_euler_angle_max` and `control:indoor_control_vz_max`. Default: `False` / indoor.

control:euler_angle_max *Usr: read/write*

Maximum slope for pitch and roll angles in radians (1.0 rad ≈ 57.295°). This effects directly the maximum speed of the drone meaning that 100% speed (respectively the value `1.0`) of the movement-commands (section 3.3 beginning on page 26) will be faster or slower, depending on this setting. The value should be between `0.0` and `0.52` (≈30°). Higher values might work, but the drone might have problems to hold its altitude and nosedive.
By editing this parameter, the suitable values and the drone's behaviour indoors respectively outdoors (depending on the `control:outdoor`-status) will be changed.

control:control_vz_max *Usr: read/write*

Drone's maximum vertical speed in millimetre per second. The value should be between `200` and `2000`. Beyond these values the drone may become unstable.
By editing this parameter, the suitable values and the drone's behaviour indoors respectively outdoors (depending on the `control:outdoor`-status) will be changed.

control:control_yaw *Usr: read/write*

Drone's maximum speed for yaw angles in radians per second. The value should be between `0.7` and `6.11` (≈ 40°/s to 350°/s). Beyond these values the drone may become unstable.
By editing this parameter, the suitable values and the drone's behaviour indoors respectively outdoors (depending on the `control:outdoor`-status) will be changed.

control:indoor_euler_angle_max *Usr: read/write*

Maximum slope for pitch and roll angles in radians (1.0 rad ≈ 57.295°). This effects directly the maximum speed of the drone meaning that 100% speed (respectively the value `1.0`) of the movement-commands (section 3.3 beginning on page 26), will be faster or slower, depending on this setting. The value should be between `0.0` and `0.52` (≈30°). Higher values might work, but the drone might have problems to hold its altitude and nosedive.
Used when `control:outdoor` is `False` and may already be set by editing `control:euler_angle_max`.

control:indoor_control_vz_max *Usr: read/write*

Drone's maximum vertical speed in millimetre per second. This value should be between `200` and `2000`. Beyond these values the drone may become unstable.
Used when `control:outdoor` is `False` and may already be set by editing `control:control_vz_max`.

control:indoor_control_yaw *Usr: read/write*

Drone's maximum yaw-speed angles in radians per second. The value should be between `0.7` and `6.11` (≈ 40°/s to 350°/s). Beyond these values the drone may become unstable.
Used when `control:outdoor` is `False` and may already be set by editing `control:control_yaw`.

control:outdoor_euler_angle_max *Usr: read/write*

Maximum slope for pitch and roll angles in radians (1.0 rad ≈ 57.295°). This effects directly the maximum speed of the drone meaning that 100% speed (respectively the value `1.0`) of the movement-commands (section 3.3 beginning on page 26), will be faster or slower, depending on this setting. The value should be between `0.0` and `0.52` (≈ 30°). Higher values might work, but the drone might have problems to hold its altitude and nosedive.
Used when `control:outdoor` is `True` and may already be set by editing `control:euler_angle_max`.

control:outdoor_control_vz_max *Usr: read/write*

Drone's maximum vertical speed in millimetre per second. This value should be between `200` and `2000`. Beyond these values the drone may become unstable.
Used when `control:outdoor` is `True` and may already be set by editing `control:control_vz_max`.

control:outdoor_control_yaw *Usr: read/write*

Drone's maximum yaw-speed in radians per second. The value should be between `0.7` and `6.11` (≈ 40°/s to 350°/s). Beyond these values the drone may become unstable.
Used when `control:outdoor` is `True` and may already be set by editing `control:control_yaw`.

control:control_iphone_tilt *Usr: read/write*

Correction angle in radians (1.0 rad ≈ 57.295°) when drone is controlled by accelerometers of an iPhone. A smart phone is normally held in a tilted position and not flat (meaning that the drone would constantly fly backwards): in order to accelerate and decelerate the drone by tilting the phone, the correction angle is necessary. Default: 0.34906584 (≈ 20°).

5.3 Detect

detect:detect_type *Sess: read/write*

Shows what type of tag/marker is detectable.
Modifying this seems useless as the detection works always anyway (tested with firmware version 2.3.3) as soon as a roundel-/marker-/tag-type has been set in `detect:detections_select_h` or `detect:detections_select_v`.

Val	Type of detection	Note
2	2D horizontal tags on drone shells	-
3	Detection disabled	-
4	Roundel on ground	-
5	Oriented roundel on ground	-
6	Uniform stripe on ground	-
7	Roundel in front	-
8	Oriented roundel in front	-
9	Vertical Stripes	-
10	Several detections at the same time	suggested
11	Orange and green cap in front	-
12	Black and white roundel	-
13	2nd version of shell/tag in front	-
14	Tower-side in front	-

Table 5.5: Official values to choose tag detection methods.

`detect:detections_select_h` and `detect:detections_select_v` will be reset to *0*, if `detect:detect_type` is modified.
The roundel and a modified roundel can be found on pages 75 and 76, the black and white oriented roundel is on page 77.

detect:detections_select_h *Sess: read/rwite*

Enables tags for detection by front camera.

Shell-Tag :	1	
Roundel :	2	find them on page 75 & 76
Black Roundel :	4	
Stripe :	8	
Cap :	16	
Shell-Tag V2 :	32	
Tower Side :	64	
Oriented Roundel :	128	find it on page 77

Table 5.6: Tag detection enabling values.

Add the values to detect more than one tag. Value will be set to *0* when `detect:detect_type` is modified.

detect:detections_select_v_hsync *Sess: read only*

Enables tags for detection by ground camera, synchronized with the front camera. See table 5.6 within description of `detect:detections_select_h` above for the values to enable tags.
Value will be set to *0* when `detect:detect_type` is modified.
It is recommended not to use `detect:detections_select_v` and this tag on ground detection at the same time.

detect:detections_select_v *Sess: read/write*

Enables tags for detection by ground camera. See table 5.6 within description of `detect:detections_select_h` above for the values to enable tags.
Value will be set to *0* when `detect:detect_type` is modified.
It is recommended not to use `detect:detections_select_v_hsync` and this tag on ground detection at the same time.

detect:enemy_colors *Std: read/write*

Type of game objects and other drone detection. Use following values to modify:

1	Drones with green and orange coverage
2	Drones with yellow and orange coverage
3	Drones with blue and orange coverage
16	AR-race finish line (not official)
17	AR-race donut (not official)

Table 5.7: Settings for different flying-modes.

detect:enemy_without_shell *Std: read/write*

Type of detecting enemy drones coverage.

0	Detection of drones with indoor coverage
1	Detection of drones with outdoor coverage

Table 5.8: Settings to change coverage detection of enemies.

5.4 Video

video:camif_fps *Std: read only*

Actual frame rate of the video interface.

video:camif_buffers *Std: read only*

Shows the buffer-size of the video interface.

video:video_slices *Sess: read/write*

For Parrot's internal debugging, do not modify.

video:num_trackers *Std: read only*

Used number of tracking-points for optical speed estimation.

video:video_live_socket *Sess: read/write*

For Parrot's internal debugging, do not modify.

video:video_codec *Sess: read only* *MConf: read/write*

The actual used videocodec, the resolution of video and usage of a recording-video-stream.

Value	Codec	Resolution	Recording-stream	Note
`128`	MPEG4	640 × 368	disabled	`mp4Video()` (3.6.11, P. 37)
`129`	H.264	640 × 360	disabled	`sdVideo()` (3.6.9, P. 37)
`130`	MPEG4	640 × 368	H.264 1280 × 720	-
`131`	H.264	1280 × 720	disabled	`hdVideo()` (3.6.10, P. 37)
`132`	MPEG4	640 × 368	disabled	SLR-coded stream
`133`	H.264	640 × 360	disabled	SLR-coded stream
`134`	H.264	1280 × 720	disabled	SLR-coded stream
`135`	H.264	dynamic	disabled	resolution according to bitrate
`136`	MPEG4	640 × 368	H.264 640 × 360	-

Table 5.9: Values for the video-codec, -resolution and recording-stream usage.

MPEG4 is also known as MPEG4.2, H264 is also known as MPEG4.10. The term SLR is not clear, could stand for "Simple LR parser". Some values can be set by PS-Drone-API-commands. The video-recording-stream has always 30 fps and will, when enabled, be stored on an USB flash drive or sent to the client.

video:video_channel *Sess: read/write*

Index of the drone's actively used camera:

0 :	Frontcamera (Default)	implemented by `frontCam()`, 3.6.8, P. 36
1:	Groundcamera	implemented by `groundCam()`, 3.6.9, P. 36

Table 5.10: Settings to switch used camera.

video:codec_fps *Sess: read/write*

Used frame rate of the video-stream. The frame rate can be set from 1 to 30 fps.
This setting can also be done by the command `videoBitrate()`, described in section 3.6.15 on page 38.

video:bitrate_ctrl_mode *Std: read only* *MConf: read/write*

Status of the drone's video-stream bitrate-control. Altering the bitrate-control-mode may reduce the video-stream's bandwidth.

0 :	Constant bitrate as set in `video:max_bitrate` (Default)
1 :	Bitrate variates from 250kBit to the value set in `video:max_bitrate`
2 :	Constant bitrate as set in `video:bitrate`

Table 5.11: Values to change the bitrate-control-mode.

video:max_bitrate *Std: read only*

Bitrate of the drone's video-stream in kBit. If `video:bitrate_ctrl_mode` is set to `0`, this value will be used as constant bitrate and will be used as the maximum of a variable bitrate, if `video:bitrate_ctrl_mode` was set to `1`. Parrot recommends the range from 500 to 4000 as typical values, depending on what bitrate the client is able to decode.
This setting can also be done by the command `videoBitrate()`, described in section 3.6.15 on page 38.

video:bitrate *Std: read only* *MConf: read/write*

Bitrate of the drone's video-stream in kBit.
This value is used, if `video:bitrate_ctrl_mode` is set to `2`. Parrot recommends the range from 500 to 4000 as typical values.
This setting can also be done by the command `videoBitrate()`, described in section 3.6.15 on page 38.

video:video_file_index *Std: read/write*

The number of the last recorded video on the USB flash drive.
Parrot suggests not to modify this value.

video:bitrate_storage *App: read/write*

Bitrate of the video-recording stream.

video:video_storage_space *Std: read only*

Used size of the WiFi-video-recording-buffer.

video:video_on_usb *Std: read/write*

Usage of an USB-Stick as video-recording-device.
If an USB flash drive is connected and this value is set to `True`, the drone's video-recording-stream will be stored on the device.
If the value is set to `False`, no USB flash drive is connected or the available storage space is less then 100MB; the video-recording-stream will be available per network stream.
The video-recording-stream is always H.264-encoded, with 30 frames per second and a resolution of 640 × 360 or 1280 × 720. If not recorded on an USB flash drive, it will be available at TCP-port 5553.

5.5 LEDs, Syslog and Pic

leds:leds_anim *Std: read/write*

Drone shows pre-set animation with the LEDs on the end of its arms. The parameter string to set an animation contains three parameters, divided by commas: the number of wished animation, its frequency in hertz and its duration in seconds. The frequency has to be a floating point value, represented as 32bit integer, e.g. `0.2` is represented by `-1102263091`.

anim.	description
0	All LEDs are red, then all LEDs are green
1	All LEDs are green, then all LEDs are off
2	All LEDs are red, then all LEDs are off
3	All LEDs are orange, then all LEDs are off
4	All LEDs flash fast green/red/off
5	Front LEDs alternate fast yellow/off, rear LEDs are red
6	Front LEDs are green, read LEDs are red
7	All LEDs are red
8	All LEDs are green
9	Front left LED is red, all other are off. The light moves clockwise.
10	All LEDs are off
11	Left LEDs are off, right: rear LED is red, then rear LED is off and front LED is yellow. Then all LEDs are off
12	Right LEDs are off, left: rear LED is red, then rear LED is off and front LED is yellow. Then all LEDs are off
13	Rear LEDs are red, then are off and front LEDs are yellow. All LEDs are off
14	Front left LED is green, all other LEDs are red
15	Front right LED is green, all other LEDs are red
16	Rear right LED is green, all other LEDs are red
17	Rear left LED is green, all other LEDs are red
18	Left LEDs are green, right LEDs are red
19	Left LEDs are red, right LEDs are green
20	Front LEDs are green, rear LEDs are red, then all LEDs are off

Table 5.12: Possible values for `leds:leds_anim` and drone's behaviour.

Example: With parameter string ¨`3,-1102263091,3`¨ all LEDs flash orange with 0.2 Hz for three seconds.
This setting can also be done by the command `led()`, described in section 3.8.7 on page 45.

syslog:output | syslog:max_size | syslog:nb_files *Std: read only*

For Parrot's internal debugging.

pic:ultrasound_freq *Std: read/write*

Frequency of the ultrasound for altitude measurement.

7 :	22.22 kHz
8 :	25.00 kHz (Default)

Table 5.13: Values to change ultrasound frequency.

pic:ultrasound_watchdog *Std: read/write*

For Parrot's internal debugging, do not modify.

pic:pic_version *Std: read only*

Software-version of the drone's Nav-board.

5.6 Custom

custom:application_id *Std: read/write*

Shows the current application ID in eight hexadecimal digits, stores application settings or creates them if they do not exist. To delete a set of settings, negate the ID by putting a minus (-) in front. By ID ¨-all¨ you delete all saved entries. This setting can also be done by command `setConfigApplicationID()`, described in section 3.5.6 on page 33; or set pre-set application-, profile- and session-IDs by command `setConfigAllID()` at once, described in section 3.5.7 on page 33.

custom:application_desc *App: read/write*

The description of the current application.

custom:profile_id *Ses: read/write*

Shows the current profile/user ID in eight hexadecimal digits, stores application settings or creates them if they do not exist. To delete a set of settings, negate the ID by putting a minus (-) in front. By ID ¨-all¨ you delete all saved entries. This setting can also be done by command `setConfigUserID()`, described in section 3.5.6 on page 32; or set pre-set application-, profile- and session-IDs by command `setConfigAllID()` at once, described in section 3.5.7 on page 33.

custom:profile_desc *Usr: read/write*

The description of the current profile/user.

custom:session_id *Ses: read only*

Shows the current session ID in eight hexadecimal digits, stores application settings or creates them if they do not exist. To delete a set of settings, negate the ID by putting a minus (-) in front. By ID ¨-all¨ you delete all saved entries. This setting can also be done by command *`setConfigSessionID()`*, described in section 3.5.6 on page 32; or set pre-set application-, profile- and session-IDs by command *`setConfigAllID()`* at once, described in section 3.5.7 on page 33.

custom:session_desc *Ses: read/write*

The description of the current session.

5.7 GPS, Network and Userbox

gps:latitude *Std: read/write*

The drone's latitude (north/south), set by GPS controlling device and used for media tagging and userbox recording. The value of latitude is a double precision floating point number represented as 64bit integer, also when set. So the value *`50.130862`* has to be represented by *`4632252108916466947`*.
Note: The GPS receiver is an extra device, connected to the drone's USB-port.

gps:longitude *Std: read/write*

The drone's longitude (east/west), set by GPS controlling device, used for media tagging and userbox recording. The value of longitude is a double precision floating point number represented as 64bit integer, also when set. So the value *`8.455938`* has to be represented by *`4620949887957991902`*.
Note: The GPS receiver is an extra device, connected to the drone's USB-port.

gps:altitude *Std: read/write*

The drone's altitude, set by GPS controlling device and used for media tagging and userbox recording. The value of altitude is a double precision floating point number represented as 64bit, also when set. So the value *`189.8`* has to be represented by *`4640882010386700698`*.
Note: The GPS receiver is an extra device, connected to the drone's USB-port.

network:ssid_single_player *Std: read/write*

The drone's WiFi-SSID. A change will apply after the drone's next reboot.

network:ssid_multi_player *Std: read/write*

Reserved for further usage.

network:owner_mac *Std: read/write*

Shows the MAC-address of the client connected to the drone.
Set value to `00:00:00:00:00:00` to unpair.

network:wifi_rate *Std: read/write*

For Parrot's internal debugging, do not modify.

network:wifi_mode *Std: read/write*

Represents the connection mode of the drone's WiFi-subsystem.

0 :	The drone is connectable as a WiFi-access-point (Default)
1 :	The drone is connectable in Ad-Hoc-modus
2 :	WiFi is in client-mode and the drone connects to an existing access point

Table 5.14: Values to change the drone's WiFi-mode.

Changes are not suggested for multi-configurations.

userbox:userbox_cmd *Ses: read/write*

This Option gives the possibility to save the drone's GPS.

0	Stop	
1	Cancel	
2	Start	current date [date]
3	Photo	delay in sec [uint], number of pictures [uint] and current date [date]

Table 5.15: Tag detection enabling values.

Extra parameters should be seperated by a comma, e.g. `2,20141222_130600`.
By *starting* a recording, the drone creates the <tempdir>-folder and a binary-file named `userbox_`<timestamp> which contains the GPS-positions. When taking a *photo* the shots are made by the front camera and stored in <tempdir>, named ¨`picture_`<date>`.jpg`¨.
If a recording got *canceled*, all recordings stop and <tempdir>-folder is deleted.
By *stopping* a recording the <tempdir>-folder is renamed to ¨`/data/video/boxes/flight_`<date>`/`¨.
Use FTP to download the recorded positions and pictures from the drone.

<timespamp> represents the time since the last boot of the drone.

<date> has (<...>) to have the format: YYYYMMDD_hhmmss

<tempdir> represents following directory in the drone's filesystem:
¨`/data/video/boxes/tmp_flight_`<date>`/`¨

Note: The GPS receiver is an extra device and is connected to the drone's USB-port.

A List of configuration and Tags

Example listing of Ar.Drone 2.0 configuration

Name	Value
general:num_version_config	1
general:num_version_mb	33
general:num_version_soft	2.3.3
general:drone_serial	PS721xxxxxxxxxxxxx
general:soft_build_date	2012-11-26 12:16
general:motor1_soft	1.43
general:motor1_hard	5.0
general:motor1_supplier	1.1
general:motor2_soft	1.43
general:motor2_hard	5.0
general:motor2_supplier	1.1
general:motor3_soft	1.43
general:motor3_hard	5.0
general:motor3_supplier	1.1
general:motor4_soft	1.43
general:motor4_hard	5.0
general:motor4_supplier	1.1
general:ardrone_name	My ARDrone
general:flying_time	28109
general:navdata_demo	TRUE
general:com_watchdog	2
general:video_enable	FALSE
general:vision_enable	TRUE
general:vbat_min	9000
control:accs_offset	-3.9962664e+03 4.1537573e+03 4.1192974e+03
control:accs_gains	1.9310879e+00 6.4174724e-03 -1.7682407e-02 -1.5522186e-03 -1.9930630e+00 -2.9528014e-02 -4.4175964e-02 7.7207056e-03 -1.9653542e+00
control:gyros_offset	3.7773750e+01 -9.2787504e+00 1.1687500e+00
control:gyros_gains	1.0552111e-03 -1.0667081e-03 -1.0715150e-03
control:gyros110_offset	1.6625000e+03 1.6625000e+03
control:gyros110_gains	1.5271631e-03 -1.5271631e-03
control:magneto_offset	2.9589743e+02 -1.1218007e+02 -6.8020508e+02
control:magneto_radius	1.7466907e+02

...

. . .

Name	Value
control:gyro_offset_thr_x	4.0000000e+00
control:gyro_offset_thr_y	4.0000000e+00
control:gyro_offset_thr_z	5.0000000e-01
control:pwm_ref_gyros	500
control:osctun_value	63
control:osctun_test	TRUE
control:altitude_max	20000
control:altitude_min	50
control:outdoor	FALSE
control:flight_without_shell	FALSE
control:autonomous_flight	TRUE
control:flight_anim	0,0
network:ssid_single_player	ardrone2_xxxxxx
network:ssid_multi_player	ardrone2_xxxxxx
network:wifi_mode	0
network:wifi_rate	0
network:owner_mac	00:00:00:00:00:00
pic:ultrasound_freq	8
pic:ultrasound_watchdog	3
pic:pic_version	184877090
video:camif_fps	30
video:camif_buffers	2
video:num_trackers	12
video:video_storage_space	15360
video:video_on_usb	FALSE
video:video_file_index	2
leds:leds_anim	0,0,0
detect:enemy_colors	1
detect:enemy_without_shell	1
syslog:output	7
syslog:max_size	102400
syslog:nb_files	5
general:localtime	0
general:navdata_options	65537
control:control_level	0
video:bitrate	1000
video:bitrate_ctrl_mode	0
video:bitrate_storage	4000
custom:application_desc	Default application configuration
control:euler_angle_max	2.0943999e-01
control:control_iphone_tilt	3.4906584e-01
control:control_vz_max	7.0000000e+02
control:control_yaw	1.7453290e+00

. . .

. . .

Name	Value
control:manual_trim	FALSE
control:indoor_euler_angle_max	2.0943999e-01
control:indoor_control_vz_max	7.0000000e+02
control:indoor_control_yaw	1.7453290e+00
control:outdoor_euler_angle_max	3.4906584e-01
control:outdoor_control_vz_max	1.0000000e+03
control:outdoor_control_yaw	3.4906585e+00
custom:profile_desc	Default profile configuration
control:flying_mode	0
control:hovering_range	1000
video:codec_fps	30
video:video_codec	129
video:video_slices	0
video:video_live_socket	0
video:max_bitrate	1000
video:video_channel	0
detect:groundstripe_colors	16
detect:detect_type	3
detect:detections_select_h	0
detect:detections_select_v_hsync	0
detect:detections_select_v	0
userbox:userbox_cmd	0
gps:latitude	5.0000000000000000e+02
gps:longitude	5.0000000000000000e+02
gps:altitude	0.0000000000000000e+00
custom:application_id	00000000
custom:profile_id	00000000
custom:session_id	00000000
custom:session_desc	00000000

Listing A.1: Example listing of Ar.Drone 2.0 configuration

Figure A.1: Roundel

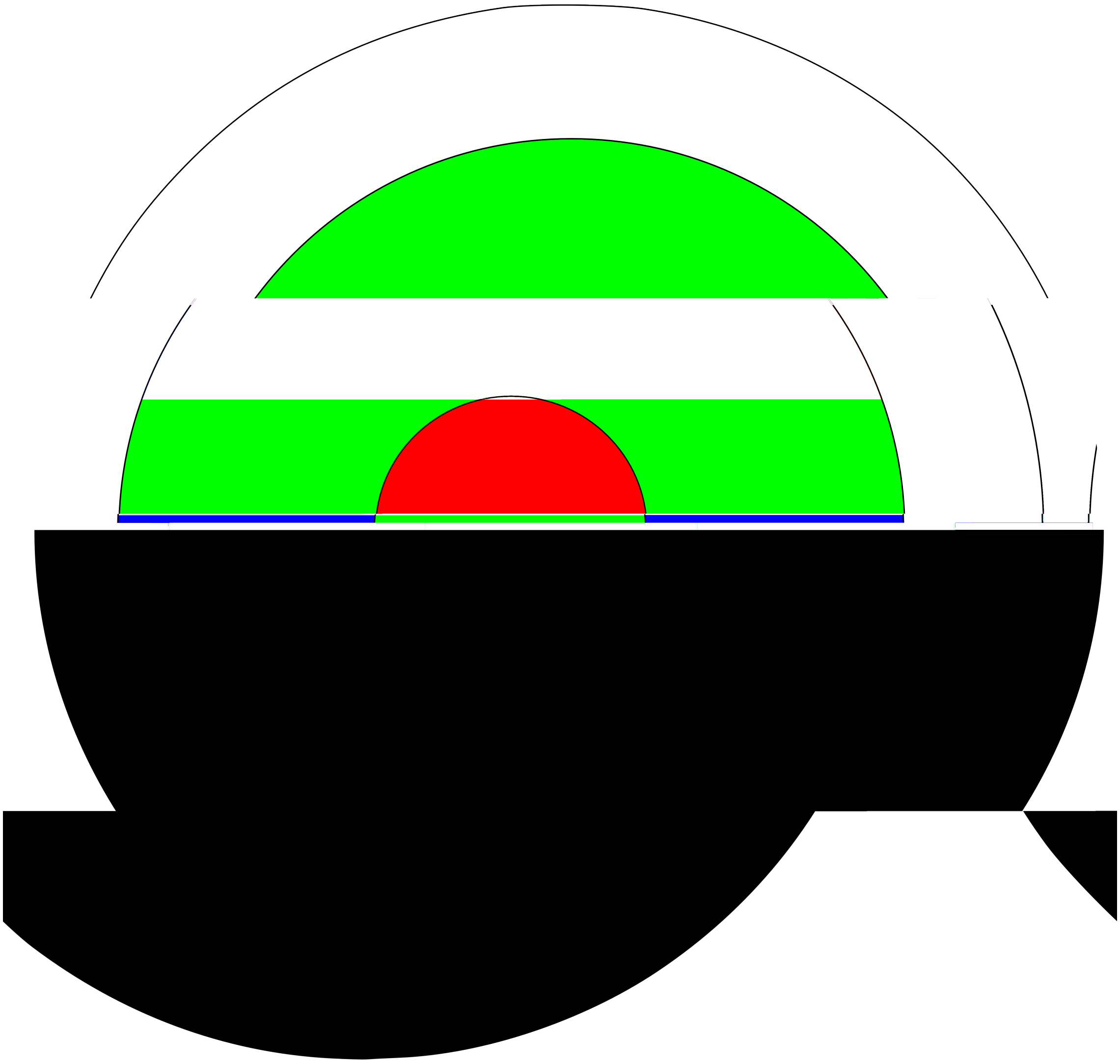


Figure A.2: Modified Roundel for a better detection

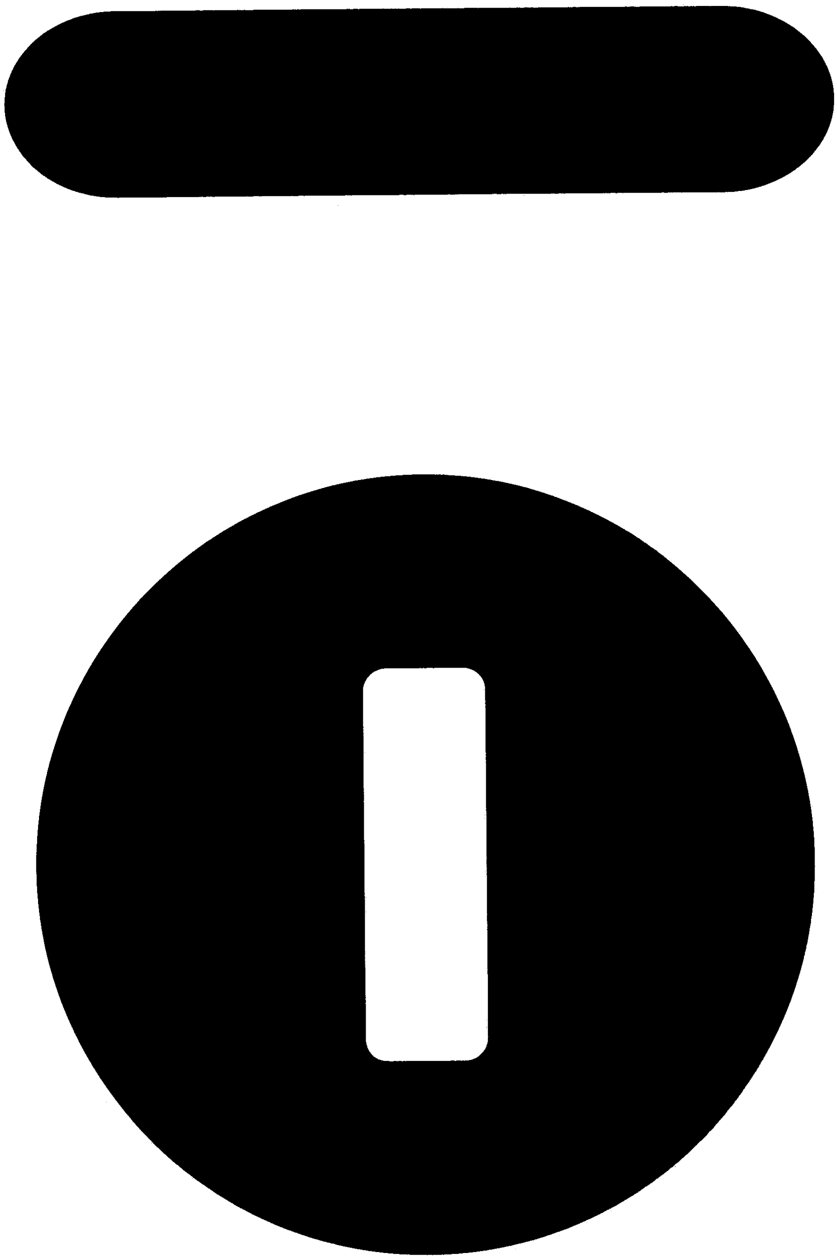


Figure A.3: Black and white Oriented Roundel