



RigidMotion Documentation

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PREAMBLE

RigidMotion enables to define or compute rigid motions for arrays (as defined in Converter documentation) or for CGNS/Python trees (pyTrees).

This module is part of Cassiopee, a free open-source pre- and post-processor for CFD simulations.

For use with the array interface, you have to import RigidMotion module:

```
import RigidMotion
```

For use with the pyTree interface:

```
import RigidMotion.PyTree as RigidMotion
```


LIST OF FUNCTIONS

– Prescribed motions

RigidBodyMotion.PyTree. setPrescribedMotion1(t, name)	Define a motion of type 1 (time strings).
RigidBodyMotion.PyTree. setPrescribedMotion2(t, name)	Define a motion of type 2 (rotor)
RigidBodyMotion.PyTree. setPrescribedMotion3(t, name)	Define a motion of type 3 (constant rotation+translation speed).

– General functions

RigidBodyMotion.PyTree.evalPosition(a, time[, F])	Move the mesh with defined motion to time t.
RigidBodyMotion.PyTree.evalGridSpeed(a, time)	Eval grid speed at given time.

CONTENTS

`RigidMotion.setPrescribedMotion1(a, motionName, tx="0", ty="0", tz="0",
cx="0", cy="0", cz="0", ex="0", ey="0",
ez="0", angle="0")`

Set a prescribed motion defined by a translation of the origin (tx,ty,tz), the center of a rotation (cx,cy,cz), the second point of the rotation axis (ex,ey,ez) and the rotation angle in degrees. They can depend on time {t}.

Exists also as an in-place version (`_setPrescribedMotion1`) which modifies `a` and returns `None`.

Parameters

- **a** ([array, list of arrays] or [pyTree, base, zone, list of zones]) – Input data
- **tx** (string) – translation in x motion string
- **ty** (string) – translation in y motion string
- **tz** (string) – translation in z motion string
- **cx** (string) – rotation center x coordinate motion string
- **cy** (string) – rotation center y coordinate motion string
- **cz** (string) – rotation center z coordinate motion string
- **ex** (string) – rotation axis x coordinate motion string
- **ey** (string) – rotation axis y coordinate motion string
- **ez** (string) – rotation axis z coordinate motion string
- **angle** (string) – rotation angle motion string

Example of use:

- Set a prescribed motion of type 1 (pyTree):

```
# - setPrescribedMotion1 (pyTree) -  
# Motion defined by time string  
import RigidMotion.PyTree as R  
import Converter.PyTree as C  
import Geom.PyTree as D  
  
a = D.sphere((1.2,0.,0.), 0.2, 30)  
a = R.setPrescribedMotion1(a, 'trans', tx="{t}")  
  
C.convertPyTree2File(a, 'out.cgns')
```

```
RigidMotion.setPrescribedMotion2(a, motionName, transl_speed, psi0, psi0_b,  
                                alp_pnt, alp_vct, alp0, rot_pnt, rot_vct,  
                                rot_omg, del_pnt, del_vct, del0, delc, dels,  
                                bet_pnt, bet_vct, bet0, betc, bets, tet_pnt,  
                                tet_vct, tet0, tetc, tets, span_vct, pre_lag_pnt,  
                                pre_lag_vct, pre_lag_ang, pre_con_pnt,  
                                pre_con_vct, pre_con_ang)
```

Set a prescribed motion defined by a rigid rotor motion. Arguments are identical to `elsA` rotor motion.

Exists also as an in-place version (`_setPrescribedMotion2`) which modifies `a` and returns `None`.

Parameters

- **a** ([array, list of arrays] or [pyTree, base, zone, list of zones]) – Input data
- **transl_speed** (a 3-tuple of floats) – translation speed
- **psi0** (float) – initial pitch angle (in degrees)
- **psi0_b** (float) – angle for blade position wrt leading blade (in degrees)
- **alp_pnt** (a 3-tuple of floats) – origin of rotor shaft
- **alp_vct** (a 3-tuple of floats) – axis of rotor shaft
- **alp0** (float) – rotor shaft angle (in degrees)
- **rot_pnt** (3-tuple of floats) – rotation center
- **rot_vct** (3-tuple of floats) – rotation axis
- **rot_omg** (float) – rotor angular velocity (in radians per sec)
- **del_pnt** (3-tuple of floats) – origin of lead-lag
- **del_vct** (3-tuple of floats) – lead-lag axis

- **del0** (float) – lead-lag angle (in degrees)
- **delc** (tuple of floats) – cosine part of harmonics for lead-lag
- **dels** (tuple of floats) – sine part of harmonics for lead-lag
- **bet_pnt** (3-tuple of floats) – origin of flapping motion
- **bet_vct** (3-tuple of floats) – flapping axis
- **bet0** (float) – flapping angle (in degrees)
- **betc** (tuple of floats) – cosine part of harmonics for conicity
- **bets** (tuple of floats) – sine part of harmonics for conicity
- **tet_pnt** (3-tuple of floats) – origin of pitching motion
- **tet_vct** (3-tuple of floats) – pitching axis
- **tet0** (float) – collective pitch angle (in degrees)
- **tetc** (tuple of floats) – cyclic pitch cosine part
- **tets** (tuple of floats) – cyclic pitch sine part
- **span_vct** (3-tuple of floats) – reference blade spanwise axis
- **pre_lag_pnt** (3-tuple of floats) – origin of pre-lag
- **pre_lag_vct** (3-tuple of floats) – pre-lag axis
- **pre_lag_ang** (float) – pre-lag angle (in degrees)
- **pre_con_pnt** (3-tuple of floats) – origin of pre-conicity
- **pre_con_vct** (3-tuple of floats) – pre-conicity axis
- **pre_con_ang** (float) – pre-conicity angle (in degrees)

Example of use:

- Set a prescribed motion of type 2 (pyTree):

```
# - setPrescribedMotion2 (pyTree) -
# Motion defined by a rotor motion
import RigidMotion.PyTree as R
import Converter.PyTree as C
import Generator.PyTree as G

# Mime une pale suivant x, quart avant
a = G.cart((0.2,-0.075,0), (0.01,0.01,0.1), (131,11,1))
RotorMotion={'Motion_Blade1':{'initial_angles' : [0.,0], #PSI0,PSI0_b
                                'alp0': -12.013,'alp_pnt' : [0.,0.,0.], 'alp_vct
↪': [0.,1.,0.]},
```

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```

↪omg':104.71,
                                'rot_pnt' : [0.,0.,0.], 'rot_vct':[0.,0.,1.], 'rot_
                                'span_vct' : [1.,0.,0.],
                                'pre_lag_pnt' : [0.075,0.,0.], 'pre_lag_vct' : [0.,
↪0.,1.], 'pre_lag_ang' : -4.,
                                'pre_con_pnt' : [0.,0.,0.], 'pre_con_vct' : [0.,1.,
↪0.], 'pre_con_ang' : 0.,
                                'del_pnt' : [0.075,0.,0.], 'del_vct' : [0.,0.,1.],
↪'del0' : -0.34190,
                                'del1c' : 0.48992E-01 , 'del1s': -0.95018E-01,
                                'bet_pnt' : [0.076,0.,0.], 'bet_vct' : [0.,1.,0.],
↪'bet0' : -2.0890,
                                'bet1c' : 3.4534, 'bet1s' : 0.0,
                                'tet_pnt' : [0.156,0.,0.], 'tet_vct' : [1.,0.,0.],
↪'tet0' : 12.807,
                                'tet1c' : 1.5450, 'tet1s' : -3.4534}}

dictBlade = RotorMotion["Motion_Blade1"]
init_angles = dictBlade["initial_angles"]
psi0 = init_angles[0]; psi0_b = init_angles[1]
transl_speed = (-87.9592,0.,0.)
alp_pnt = dictBlade["alp_pnt"]
alp_vct = dictBlade["alp_vct"]
alp0 = dictBlade["alp0"]
rot_pnt = dictBlade["rot_pnt"]
rot_vct = dictBlade["rot_vct"]
rot_omg = dictBlade["rot_omg"]
del_pnt = dictBlade["del_pnt"]
del_vct = dictBlade["del_vct"]
del0 = dictBlade["del0"]
delc = (dictBlade["del1c"],)
dels = (dictBlade["del1s"],)
bet_pnt = dictBlade["bet_pnt"]
bet_vct = dictBlade["bet_vct"]
bet0 = dictBlade["bet0"]
betc = (dictBlade["bet1c"],)
bets = (dictBlade["bet1s"],)
tet_pnt = dictBlade["tet_pnt"]
tet_vct = dictBlade["tet_vct"]
tet0 = dictBlade["tet0"]
tetc = (dictBlade["tet1c"],)
tets = (dictBlade["tet1s"],)
span_vct = dictBlade['span_vct']
pre_lag_pnt = dictBlade["pre_lag_pnt"]
pre_lag_vct = dictBlade["pre_lag_vct"]

```

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pre_lag_ang = dictBlade["pre_lag_ang"]
pre_con_pnt = dictBlade["pre_con_pnt"]
pre_con_vct = dictBlade["pre_con_vct"]
pre_con_ang = dictBlade["pre_con_ang"]
R._setPrescribedMotion2(a, 'Motion_Blade1', transl_speed=transl_speed,
                        psi0=psi0, psi0_b=psi0_b,
                        alp_pnt=alp_pnt, alp_vct=alp_vct, alp0=alp0,
                        rot_pnt=rot_pnt, rot_vct=rot_vct, rot_omg=rot_omg,
                        del_pnt=del_pnt, del_vct=del_vct, del0=del0,
                        delc=delc, dels=dels,
                        bet_pnt=bet_pnt, bet_vct=bet_vct, bet0=bet0,
                        betc=betc, bets=bets,
                        tet_pnt=tet_pnt, tet_vct=tet_vct, tet0=tet0,
                        tetc=tetc, tets=tets,
                        span_vct=span_vct,
                        pre_lag_pnt=pre_lag_pnt, pre_lag_vct=pre_lag_vct, pre_
↪lag_ang=pre_lag_ang,
                        pre_con_pnt=pre_con_pnt, pre_con_vct=pre_con_vct, pre_
↪con_ang=pre_con_ang)
C.convertPyTree2File(a, 'out.cgns')

```

RigidMotion.**setPrescribedMotion3**(*a*, *motionName*, *transl_speed*, *axis_pnt*,
axis_vct, *omega*)

Set a prescribed motion defined by a constant speed rotation and constant translation vector. *omega* is in rad/time unit. Since rotation is applied before translation, the center of rotation (*axis_pnt*) is moving with translation speed also.

Exists also as an in-place version (`_setPrescribedMotion3`) which modifies *a* and returns None.

Parameters

- **a** ([array, list of arrays] or [pyTree, base, zone, list of zones]) – Input data
- **transl_speed** (tuple of 3 floats) – translation vector
- **axis_pnt** (tuple of 3 floats) – rotation axis (constant in translated frame)
- **axis_vect** (tuple of 3 floats) – vector axis (constant in translated frame)
- **omega** (float) – constant rotation speed

Example of use:

- Set a prescribed motion of type 3 (pyTree):

```
# - setPrescribedMotion3 (pyTree) -
# Motion defined by a constant rotation and translation speed
import RigidMotion.PyTree as R
import Converter.PyTree as C
import Geom.PyTree as D

a = D.sphere((1.2,0.,0.), 0.2, 30)
a = R.setPrescribedMotion3(a, 'mot', transl_speed=(1,0,0))

C.convertPyTree2File(a, 'out.cgns')
```

3.1 General functions

RigidMotion.**evalPosition**(a, time)

Evaluate the position at time t according to a motion. The motion must be defined in a with setPrescribedMotion. If GridCoordinates#Init is present, it is used to compute position. Otherwise, Grid coordinates in a must be the coordinates at time=0.

Exists also as an in-place version (`_evalPosition`) which modifies a and returns None.

Parameters

- **a** ([pyTree, base, zone, list of zones]) – input data
- **time** (float) – evaluation time

Returns reference copy of a

Return type identical to input

Example of use:

- Evaluate position (pyTree):

```
# - evalPosition (PyTree) -
import RigidMotion.PyTree as R
import Generator.PyTree as G
import Converter.PyTree as C
from math import *

# Coordonnees du centre de rotation dans le repere absolu
def centerAbs(t): return [t, 0, 0]

# Coordonnees du centre de la rotation dans le repere entraine
def centerRel(t): return [5, 5, 0]
```

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```

# Matrice de rotation
def rot(t):
    omega = 0.1
    m = [[cos(omega*t), -sin(omega*t), 0],
         [sin(omega*t), cos(omega*t), 0],
         [0, 0, 1]]
    return m

# Mouvement complet
def F(t): return (centerAbs(t), centerRel(t), rot(t))

a = G.cart((0,0,0), (1,1,1), (11,11,2))

# Move the mesh
time = 3.
b = R.evalPosition(a, time, F); b[0]='moved'
C.convertPyTree2File([a,b], "out.cgns")

```

Evaluate position at given time, when motion is described by a function. $F(t)$ is a function describing motion. $F(t) = (\text{centerAbs}(t), \text{centerRel}(t), \text{rot}(t))$, where $\text{centerAbs}(t)$ are the coordinates of the rotation center in the absolute frame, $\text{centerRel}(t)$ are the coordinates of the rotation center in the relative (that is array's) frame and $\text{rot}(t)$, the rotation matrix.

Parameters

- **a** ([pyTree, base, zone, list of zones]) – input data
- **time** (float) – evaluation time
- **F** (python function) – motion function

Returns reference copy of a

Return type identical to input

Example of use:

- Evaluate position with function (pyTree):

```

# - evalPosition pour motion 2 (pyTree) -
# Rotor motion
import RigidMotion.PyTree as R
import Converter.PyTree as C
import Generator.PyTree as G
import Converter.Internal as Internal

```

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```

time0 = 0.01
a = G.cart((0.2,-0.075,0), (0.01,0.01,0.1), (131,11,1))
# Mettre tous les parametres
RotorMotion={'Motion_Blade1':{'initial_angles' : [0.,0],#PSI0,PSI0_b
                                'alp0': -12.013,'alp_pnt' : [0.,0.,0.], 'alp_vct
↪':[0.,1.,0.],
                                'rot_pnt' : [0.,0.,0.],'rot_vct':[0.,0.,1.],'rot_
↪omg':104.71,
                                'span_vct' : [1.,0.,0.],
                                'pre_lag_pnt' : [0.075,0.,0.],'pre_lag_vct' : [0.,
↪0.,1.],'pre_lag_ang' : -4.,
                                'pre_con_pnt' : [0.,0.,0.],'pre_con_vct' : [0.,1.,
↪0.],'pre_con_ang' : 0.,
                                'del_pnt' : [0.075,0.,0.],'del_vct' : [0.,0.,1.],
↪'del0' : -0.34190,
                                'del1c' : 0.48992E-01 , 'del1s': -0.95018E-01,
                                'bet_pnt' : [0.076,0.,0.],'bet_vct' : [0.,1.,0.],
↪'bet0' : -2.0890,
                                'bet1c' : 3.4534, 'bet1s' : 0.0,
                                'tet_pnt' : [0.156,0.,0.],'tet_vct' : [1.,0.,0.],
↪'tet0' : 12.807,
                                'tet1c' : 1.5450, 'tet1s' : -3.4534}}

dictBlade = RotorMotion["Motion_Blade1"]
init_angles = dictBlade["initial_angles"]
psi0 = init_angles[0]; psi0_b = init_angles[1]
transl_speed = (-87.9592,0.,0.)
alp_pnt = dictBlade["alp_pnt"]
alp_vct = dictBlade["alp_vct"]
alp0 = dictBlade["alp0"]
rot_pnt = dictBlade["rot_pnt"]
rot_vct = dictBlade["rot_vct"]
rot_omg = dictBlade["rot_omg"]
del_pnt = dictBlade["del_pnt"]
del_vct = dictBlade["del_vct"]
del0 = dictBlade["del0"]
delc = (dictBlade["del1c"],)
dels = (dictBlade["del1s"],)
bet_pnt = dictBlade["bet_pnt"]
bet_vct = dictBlade["bet_vct"]
bet0 = dictBlade["bet0"]
betc = (dictBlade["bet1c"],)
bets = (dictBlade["bet1s"],)
tet_pnt = dictBlade["tet_pnt"]
tet_vct = dictBlade["tet_vct"]

```

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```

tet0 = dictBlade["tet0"]
tetc = (dictBlade["tet1c"],)
tets = (dictBlade["tet1s"],)
span_vct = dictBlade['span_vct']
pre_lag_pnt = dictBlade["pre_lag_pnt"]
pre_lag_vct = dictBlade["pre_lag_vct"]
pre_lag_ang = dictBlade["pre_lag_ang"]
pre_con_pnt = dictBlade["pre_con_pnt"]
pre_con_vct = dictBlade["pre_con_vct"]
pre_con_ang = dictBlade["pre_con_ang"]
R._setPrescribedMotion2(a, 'Motion_Blade1', transl_speed=transl_speed,
                        psi0=psi0, psi0_b=psi0_b,
                        alp_pnt=alp_pnt, alp_vct=alp_vct, alp0=alp0,
                        rot_pnt=rot_pnt, rot_vct=rot_vct, rot_omg=rot_omg,
                        del_pnt=del_pnt, del_vct=del_vct, del0=del0,
                        delc=delc, dels=dels,
                        bet_pnt=bet_pnt, bet_vct=bet_vct, bet0=bet0,
                        betc=betc, bets=bets,
                        tet_pnt=tet_pnt, tet_vct=tet_vct, tet0=tet0,
                        tetc=tetc, tets=tets,
                        span_vct=span_vct,
                        pre_lag_pnt=pre_lag_pnt, pre_lag_vct=pre_lag_vct, pre_
↪ lag_ang=pre_lag_ang,
                        pre_con_pnt=pre_con_pnt, pre_con_vct=pre_con_vct, pre_
↪ con_ang=pre_con_ang)

b = R.evalPosition(a, time=time0); b[0]='moved'
C.convertPyTree2File(b, "out.cgns")

```

RigidMotion.evalGridSpeed(a, time)

Evaluate grid speed at given time. The position must already have been evaluated at this time.

Exists also as an in-place version (`_evalGridSpeed`) which modifies `a` and returns `None`.

Parameters

- **a** ([pyTree, base, zone, list of zones]) – input data
- **time** (float) – evaluation time

Returns reference copy of `a`

Return type identical to input

Example of use:

- Evaluate speed (pyTree):

```
# - evalGridSpeed (pyTree) -
import RigidMotion.PyTree as R
import Converter.PyTree as C
import Geom.PyTree as D

a = D.sphere((1.2,0.,0.), 0.2, 30)
a = R.setPrescribedMotion3(a, 'motion', transl_speed=(1,0,0))
b = R.evalPosition(a, time=0.1)
R._evalGridSpeed(b, time=0.1)
C.convertPyTree2File(b, 'out.cgns')
```

CHAPTER
FOUR

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