Racron

The Response Calculator for SDOF systems
Edition 0.2, for Racron Version 0.5
15 February 2002

by Panagiotis A. Vossos

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2 Overview

The `racron` program calculates the response of systems with a single degree of freedom (SDOF), due to external force or earthquake excitation. It reads a list of values describing the excitation from its input and calculates the relative displacement and relative velocity of the system at each time step. It supports both linear and bilinear systems and can utilize various time-stepping methods such as linear interpolation, central difference and both iterative and non-iterative versions of the Newmark methods. Because it is protected by the GNU General Public License, users are free to share and change it.

`racron` was written by Panagiotis A. Vossos. Right now, it is under heavy development and considered to be alpha software.

3 Simple Example

Here is a simple example of running `racron`. The program reads ASCII data from the file specified on the command line, or from standard input if no file or `-` is specified. The data is numbers separated by whitespace. An example '`datafile`' would be:

```
0        0.5665   0.30
0.012  -0.23     0.5623
```

Suppose that the above values represent an external force at a 0.1 seconds time-step, acting on a linear SDOF system with a 0.6 seconds natural period and 0.32 kg mass. To calculate its response with the default integration method, you could do:

```
racron datafile -i 0.1 -p 0.6 -m 0.32
```

The result you would get with the above command is:

```
    TIME,            RD,            RV
    ----,            --,            --
  0.0000,  0.000000e+00,  0.000000e+00
  0.1000, -1.072402e+00, -2.144803e+01
  0.2000, -3.914776e+00, -3.539947e+01
  0.3000, -5.581327e+00,  2.068456e+00
  0.4000, -2.645944e+00,  5.663920e+01
  0.5000,  2.218572e+00,  4.065113e+01
  0.6000,  3.353678e+00, -1.794902e+01
  0.7000,  5.479004e-01, -3.816654e+01
  0.8000, -2.631062e+00, -2.541272e+01
  0.9000, -3.479361e+00,  8.446758e+00
  1.0000, -1.354081e+00,  3.405883e+01
  1.1000,  1.849025e+00,  3.000329e+01
  1.2000,  3.382874e+00,  6.736932e-01
  1.3000,  2.002672e+00, -2.827773e+01
  1.4000, -1.028647e+00, -3.234866e+01
  1.5000, -3.090919e+00, -8.896767e+00
  1.6000, -2.469261e+00,  2.132993e+01
```

4 Invoking `racron`

The format for running the `racron` program is:

`racron [`*datafile*`]` *option* ...

`racron` supports the following options:

‘`--help`’
: Print an informative help message describing the options and then exit.

‘`--version`’
: Print the version number of `hello` and then exit.

‘`--earthquake`’
: Specify that the excitation is a ground acceleration (default mode).

‘`--force`’
: Specify that the excitation is an external force.

‘`--max-response`’
: Print only the maximum values of the response.

‘`--time-histories`’
: Print the complete time histories of the response (default mode).

‘`-l`’
‘`--linear`’
: Specify that the SDOF system is linear. This is the default mode, so you don’t have to use this option. Its stiffness is calculated from the given values for mass and natural period of vibration.

‘`-b` *fy* `[`*ky*`]`’
‘`--bilinear=`*fy* `[`*ky*`]`’
: Specify that the SDOF system is bilinear. The first argument specifies the yield strength and is required. The second argument specifies the yield stiffness and is optional. If you don’t supply a second argument, the system is taken to be elastoplastic.

‘`--linear-interpolation`’
: Use the linear interpolation method. This method is only applicable to linear systems.

‘`--central-difference`’
: Use the central difference method.

‘`--newmark-average`’
: Use the non-iterative average acceleration Newmark method. This is the default method.

‘`--newmark-linear`’
: Use the non-iterative linear acceleration Newmark method.

‘`--newmark-average-iterative`’
: Use the iterative average acceleration Newmark method.

‘`--newmark-linear-iterative`’
: Use the iterative linear acceleration Newmark method.

'`-i` *dt*'
'`--interval=`*dt*'
: Specify the time interval between excitation values.

'`-m` *mass*'
'`--mass=`*mass*'
: Specify the mass of the SDOF system.

'`-z` *ratio*'
'`--zeta=`*ratio*'
: Specify the damping ratio of the SDOF system.

'`-p` *period*'
'`--period=`*period*'
: Specify the natural period of vibration of the SDOF system.

'`-n` *number*'
'`--number=`*number*'
: Number of SDOF systems to solve. This option is usually used together with `--max-response` and is useful for producing response spectra. It generates systems whose natural periods are logarithmically tabulated between 0.01 and 10 seconds.

'`-A` *string*'
'`--acceleration-units=`*string*'
: Specify units of input acceleration values. Example strings are 'cm^2/s', 'in^2/s' and 'gravity'. For more details on the syntax of units declarations see the GNU `units` info page. Acceleration is printed in 'gravity' units by default.

'`-V` *string*'
'`--velocity-units=`*string*'
: Specify units of output velocity values. Example strings are 'm/s' and 'in/s'. The default value is 'cm/s'.

'`-D` *string*'
'`--displacement-units=`*string*'
: Specify units of output displacement values. Example strings are 'cm' and 'in'. The default value is 'cm'.

'`-F` *string*'
'`--force-units=`*string*'
: Specify units of input force values. Example strings are 'KN' and 'kips'. Note that if you use this option, it must come in the command line *before* the `-b` option. The default value is 'N'.

'`-M` *string*'
'`--mass-units=`*string*'
: Specify units of given mass value. Example strings are 'kg' and 'kip*s^2/in'. Note that if you use this option, it must come in the command line *before* the `-m` option. The default value is 'kg'.

'--no-headers'
: Do not print any headers in output. This is useful if you want to pipe the output of racron through another program, or paste it directly in a spreadsheet.

5 Reporting Bugs

This is the first public release of `racron`, so your feedback is greatly appreciated. If you find a bug in `racron`, please send electronic mail to '`pavos@users.sourceforge.net`'. Include the version number, which you can find by running '`racron --version`'. Also include in your message the output that the program produced and the output you expected. Questions, comments and suggestions are also appreciated.

6 References

A. K. Chopra, *Dynamics of Structures*, Prentice Hall, 1995. Chapter 5 contains the numerical methods used in `racron`.

K. J. Bathe, *Finite Element Procedures*, Prentice Hall, 1996.

Concept Index

Short Contents

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